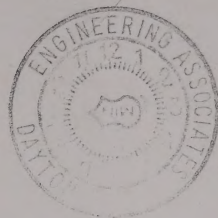
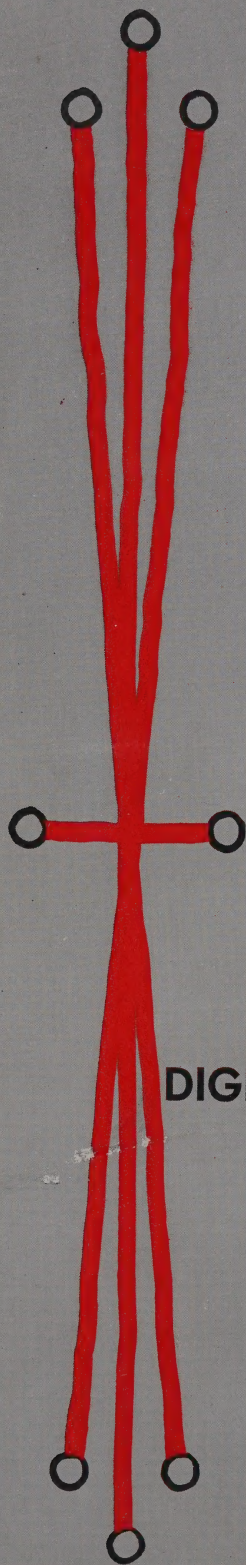


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DIGITAL AND ANALOG INSTRUMENTATION

Beckman[®] / *Berkeley Division*



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Berkeley's world-wide staff of factory trained engineering representatives work closely with our sales office and the customer. They help the customer set up newly-purchased equipment, acquaint personnel with its operation and application, and make sure that it stays in operating order. The

representative's job is not completed until he has "followed-up" to insure that the customer receives maximum use from his instruments. These men will be glad to give you personal assistance at any time. A list of Berkeley representatives follows.

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Phone: Trinity 6-3020

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147 Front St., Vestal, N. Y.
Phone: Endicott 5-0296

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Phone: Beacon 2-4804

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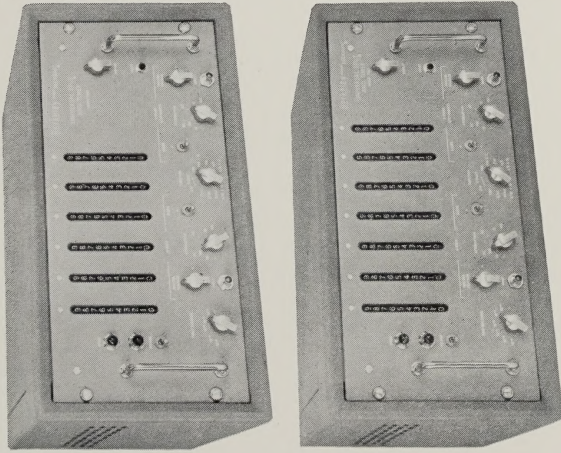
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MONTREAL, QUEBEC
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NEW MODELS 7351 and 7361

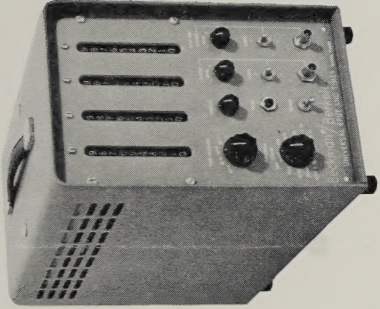
With their variable preset "count down" time bases, Models 7351 (100 kc) and 7361 (1 mc) Preset Universal EPUT* Meters are unique multipurpose instruments. Regardless of transducer conversion factors, results may be read in direct digital form by merely selecting the proper time base. These instruments will measure time intervals of any number of periods from 1 to 10,000 over the frequency range 0 to 10 kc, totalize a selectable sequence of events, divide frequency, function as single preset counters, generate pulses of varying frequency.

Applications include precise measurement of velocity, pressure, flow, viscosity, low and high frequency, frequency ratio and period, and tachometry.



NEW MODEL 5230 PORTABLE UNIVERSAL EPUT* METER

Combines many features of the popular Beckman/Berkeley 7000 series in a new, light-weight portable instrument to perform the functions of a counter, timer, time interval meter, EPUT* meter, frequency, frequency ratio or period meter. Printed circuitry contributes to compact design, increased reliability and economical cost.



MODELS 7350 and 7360 UNIVERSAL EPUT* METERS

DESCRIPTION—These truly universal instruments combine high-speed electronic counting with a precision time base in multi-purpose circuitry. They function as counters, timers, time-interval meters, EPUT* meters, frequency, frequency ratio or period meters, or as secondary frequency standards.

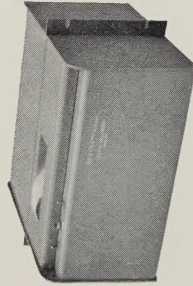
All models have provision for standardization against WWV and may be coupled to external frequency standards. Connections are provided for driving Berkeley digital printers, data converters, or in-line remote readout units.

FEATURES

- 1 0.1 v rms sensitivity
- 2 Step attenuators; trigger-adjusted noise discriminators
- 3 More stable frequency dividers
- 4 Electronic (not relay) reset
- 5 External frequency standard input connection
- 6 AC or DC coupling of all input circuits; 10 megohm input impedance

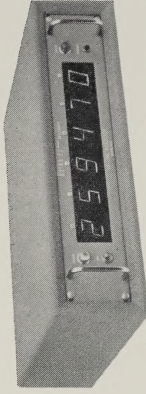
- 7 Multivoltage accessory socket to power photocells, etc.
- 8 Binary-coded output with direct connection to digital printers, data converters, inline readouts, etc.
- 9 Crystal-controlled time marker output
- 10 Unitized modular design
- 11 Larger, brighter readout numbers
- 12 Modern-styled all-aluminum cabinets

ACCESSORIES



MODEL 1452 DIGITAL PRINTER

Automatically and permanently records information from any Berkeley 5571 or 7000 Series instrument, prints data in digital form on standard adding machine tape from printer and scanner in one compact unit. May be modified to print "Time" or "Code" information simultaneously with data. Rack or bench mounted; available in up to 8 digits. One printout every 0.85 seconds. Price (6-digit), \$950.00.



MODEL 5916 IN-LINE READOUT

Large, illuminated in-line IN-PLANE figures reduce fatigue and error. Ideal for remote observation of data. Connects directly to any Berkeley 5571 or 7000 Series instrument. Presentation rate up to 15 per second; accepts binary voltages. Price (six digit unit), \$775.00.

TRANSDUCCERS

A large number of transducers especially designed for use with Berkeley counting, timing, and frequency measuring equipment are available. These include tachometer pickups, photocells, and light sources. Specifications and technical description on request.

SPECIFICATIONS & PRICES

NEW SPECIAL PRODUCTS SECTION SPEEDS SERVICE

A new department with complete specialized engineering, model shop and manufacturing facilities is ready to give prompt service on special modifications to standard Beckman/Berkeley instruments, or supply special equipment to your specifications.

BRIEF SPECIFICATIONS					
Model 5230	Model 7350	Model 7351	Model 7360	Model 7361	
RANGES-FREQUENCY	0 cps to 100 kc	0 cps to 100 kc	0 cps to 1 mc	0 cps to 1 mc	
TIME INTERVAL	100 μ sec to 10 ¹ sec	10 μ sec to 10 ¹ sec	1 μ sec to 10 ¹ sec	10 μ sec to 10 ¹ sec	
PERIOD	0 cps to 10 kc	0 cps to 100 kc	0 cps to 1 mc	0 cps to 10 kc	
TIME BASES	0.1 and 1 sec	10 μ sec to 10 sec	Time Interval* Generator	Time Interval* Generator	
CODED OUTPUT FOR DRIVING DIGITAL RECORDER, ETC.					
COUNT CAPACITY (READOUT)	\$30.00 extra	yes	yes	yes	
ACCURACY	4 digit	6 digit	5 digit	7 digit	
OSC. STABILITY	1 part in 10 ⁶ per day	$\pm$ 1 count, $\pm$ oscillator stability			
INPUT SENSITIVITY	0.25 v rms	3 parts in 10 ⁶ per week	1 part in 10 ⁶ per day	3 parts in 10 ⁶ per week	
INPUT IMPEDANCE	1 megohm, direct	0.1 volt rms**			
TRIGGER SLOPES		10 megohm, dc or ac coupled			
CABINET DIMENSIONS	12"H x 8"W x 14"D	Positive or negative 10 1/4"H x 20 3/4"W x 16 1/2"D (Rack Panel — 8 3/4" x 19")			
APPROX. SHIPPING WT. LBS.	30	60	50	60	
PRICE: (F.O.B. FACTORY)	\$575.00	\$945.00	\$1295.00	\$1245.00	
				\$1445.00	

*Variable from 0.1 millisecc to 0.9999 sec in 0.1 millisecc increments and from 1 millisecc to 9.999 sec in 1 millisecc increments
**Modification for 5 millivolt sens. @ 5 cps available, \$50.00 extra

*Variable from 0.1 millise to 0.9999 sec in 0.1 millise increments
9.999 sec in 1 millise increments
**Modification for 5 millivolt sens. @ 5 cps available, \$50.00 extra

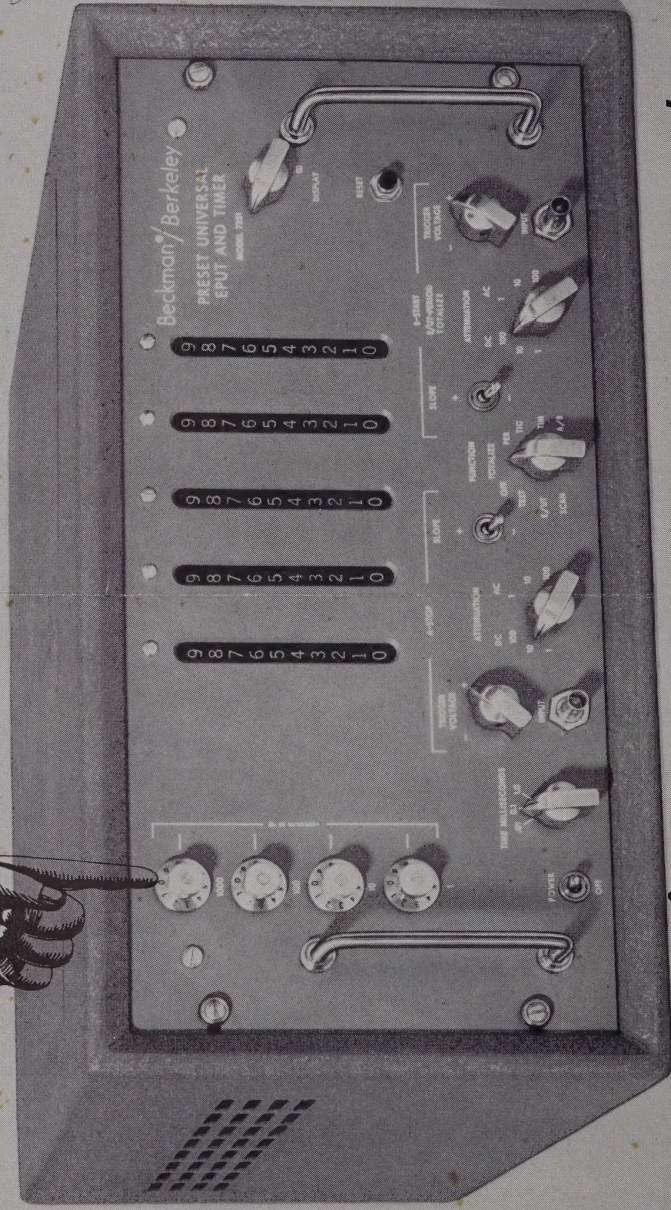
Complete technical specifications on Beckman/Berkeley Universal EPUT* meters and accessories are available promptly on request.

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Berkeley Division

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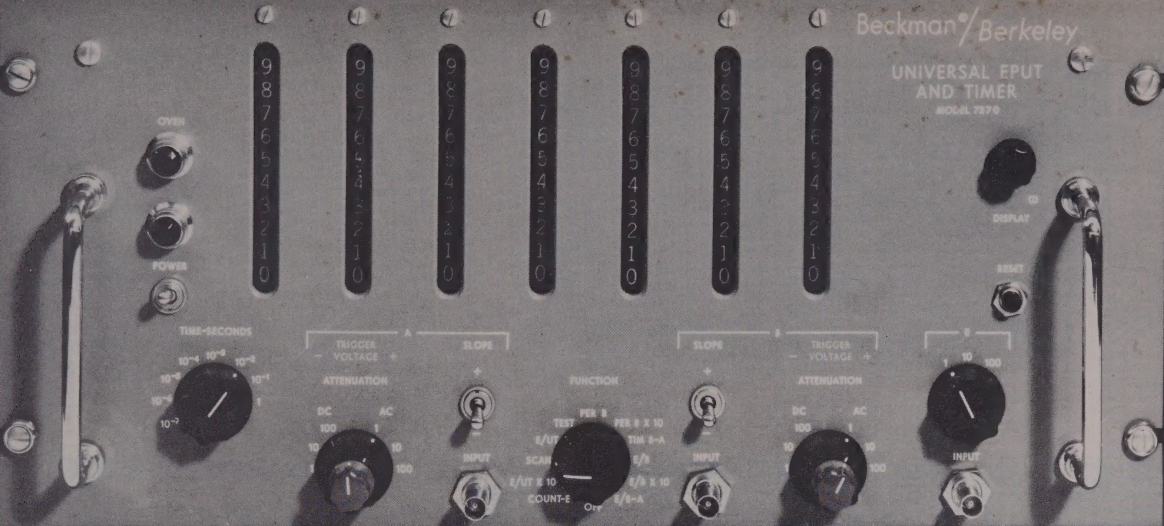


NEW

from Beckman®

Berkeley

Variable Time Base Universal EPUT® Meters
For Direct Digital Readout Without Conversion!



NOW 10 MC!

*New Beckman®/Berkeley Universal EPUT® and Timer...
a completely self-contained unit!*

KEY FEATURES

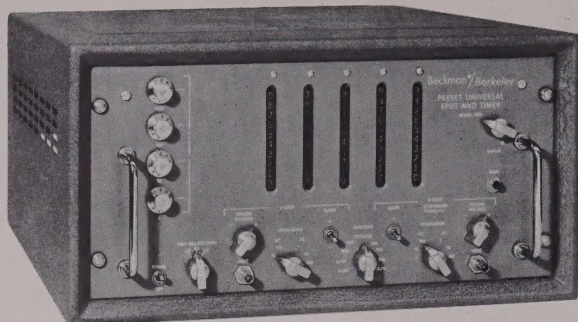
- No meter indicators—7-place direct digital readout
- Frequency measurements at 0.1 v. rms
- Three input channels for greater flexibility, more logical operation
- 10 operating functions without plug-ins
- Small, compact, moderately priced
- 0.1 microsecond resolution

Capable of direct measurements up to 10 mc—without heterodyning or requiring plug-ins—Model 7370 meets growing test instrumentation needs with the design and performance superiority characteristic of Beckman/Berkeley timer-counters, acknowledged standards of the field.

Providing three input channels, selectable time base and 7 Decimal Counting Units, Model 7370 handles every phase of counting and timing, including frequency ratio measurements. A simple switch permits the operator to select any of the following functions: "Events/Unit Time", "Period", "Time Interval Measurement", "Events/Time A-B", "Count Events", "Gate", "Events/Unit Time $\times 10$ ", "Period $\times 10$ ", "Events/Time A-B $\times 10$ ", "Scan", and "Test".

The EPUT function permits accurate measurement of frequencies up to 10 mc by direct counting for a precise period of time. The versatile Model 7370 also serves as a reliable secondary frequency standard. Other applications include phase measurement, telemetry, stability check, calibration of frequency or pulse generators, events timing, and ballistics, viscosity, and elasticity measurement.

For further description, design specifications, and prices of Beckman/Berkeley 7000 series EPUT meters, timers, and accessories—see following pages.



Preset Universal EPUT and Timers Models 7351 (100 kc) and 7361 (1 mc)

With their variable preset "count down" time bases, Models 7351 and 7361 Preset Universal EPUT Meters are unique multipurpose instruments. Regardless of transducer conversion factors, results may be read in direct digital form by merely selecting the proper time base. These instruments make fast, accurate measurements of time intervals of any preset number of periods from 1 to 10,000 over the frequency range 0 to 10 kc. They totalize a selectable sequence of events, divide frequency, function as single preset counters, generate pulses of varying frequency.

Applications include precise measurement of velocity, pressure, flow, viscosity, low and high frequency, frequency ratio and period, and tachometry.

10 MC EPUT TIMER Model 7170

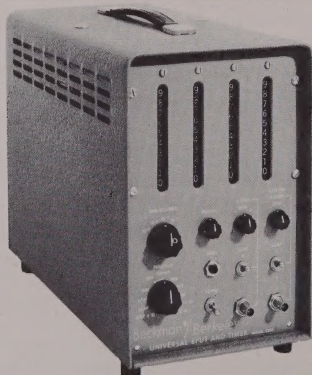
The 10 mc Model 7170 EPUT Timer automatically counts and displays the number of events that occur during a precise time interval. This new instrument has been developed for applications requiring the measurement of frequencies above the range of conventional EPUT meters. Its range is from 10 cps to 10 mc. Seven Decimal Counting Units are employed to give direct readout up to 9,999,999. The time base consists of a 1 mc, oven-stabilized, crystal-controlled oscillator and a series of frequency dividers. Connections are provided for driving Berkeley digital recording and readout units.

0.1 μ SEC. TIME INTERVAL METER Model 7270

The Beckman/Berkeley Model 7270 Time Interval Meter will measure elapsed time between two events to an accuracy of ± 0.1 microsecond. Time intervals of 0.1 or 1 microsecond may be selected, and time intervals of 1 or 10 seconds may be displayed. Accurate timing signals are provided by a 1 mc, oven-stabilized, crystal-controlled oscillator and frequency multiplier. Externally generated timing signals up to 10 mc may also be used. The Model 7270 makes Period and Time Interval Measurements to a minimum of 0.3 microseconds and, with two independent input channels and an X10 function, performs exceedingly accurate frequency ratio measurements. The timing signals are available for external use, and four-line binary-coded information from the Decimal Counting Units is also provided.

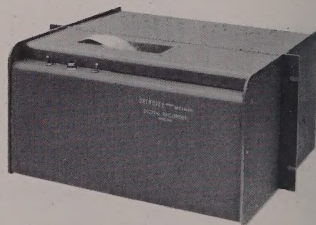
STANDARD FEATURES All 7000 Series Models

- 1 0.1 v rms sensitivity
- 2 AC or DC coupling of input circuits
- 3 Step attenuators—trigger-adjusted noise discriminators
- 4 Binary-coded output with direct connection to digital printers, data converters, in-line readouts, etc.
- 5 Stable frequency dividers
- 6 Electronic reset—not relay type
- 7 External frequency standard input connection
- 8 Multivoltage accessory socket to power photocells, etc.
- 9 Crystal-controlled time marker output
- 10 Unitized modular design
- 11 Large, bright, direct digital readout
- 12 Modern all-aluminum cabinets



Portable Universal EPUT and Timer Model 5230 (100 kc)

Combines many features of the popular Beckman/Berkeley 7000 series in a new, lightweight, portable instrument to perform the functions of a counter, timer, time interval meter, EPUT meter, frequency ratio or period meter. Printed circuitry contributes to compact design, increased reliability, and low cost.



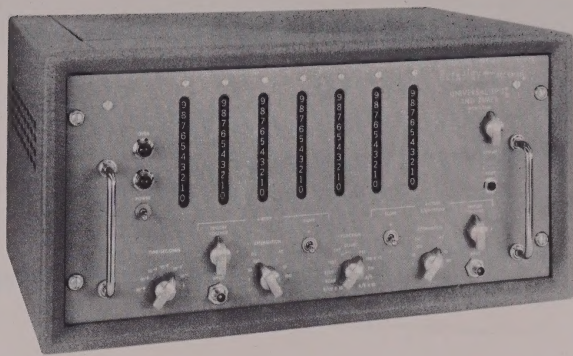
DIGITAL PRINTER Model 1452

Automatically and permanently records information from any 7000 series instrument or the 5200 portable series. Prints data in digital form on standard adding machine tape, with printer and scanner in one compact unit. May be modified to print "Time" or "Code" information simultaneously with data. Rack or bench mounted ... available in up to eight digits ... one printout every 0.85 seconds. Price (8-digit unit) \$950.00.

Standard Universal EPUT and Timers Models 7350 (100 kc) and 7360 (1 mc)

These Beckman/Berkeley universal instruments are standard in the 7000 series. They combine high-speed electronic counting with a precision time base in multipurpose circuitry. They function as counters, timers, time interval meters, EPUT meters, frequency, frequency ratio or period meters, or as secondary frequency standards.

All 7000 series universal models have provisions for standardization against WWV and may be coupled to external frequency standards. Connections are provided for driving Berkeley digital printers, data converters, or in-line remote readout indicators.



SPECIFICATIONS & PRICES

BRIEF SPECIFICATIONS	Model 5230	Model 7170	Model 7270	Model 7350	Model 7351	Model 7360	Model 7361	Model 7370
RANGES-FREQUENCY	0 cps to 100 kc	10 cps to 10 mc		0 cps to 100 kc	0 cps to 100 kc	0 cps to 1 mc	0 cps to 1 mc	10 cps to 10 mc
TIME INTERVAL	100 μ sec to 10 ³ sec		0.3 μ sec to 10 ³ sec	10 μ sec to 10 ³ sec	10 μ sec to 10 ³ sec	1 μ sec to 10 ³ sec	10 μ sec to 10 ³ sec	0.3 μ sec to 10 ³ sec
PERIOD	0 cps to 10 kc		0 to 3 mc	0 cps to 100 kc	0 cps to 10 kc	0 cps to 1 mc	0 cps to 10 kc	0 to 3 mc
TIME BASES	0.1 and 1 sec	0.1 μ sec to 10 sec	0.1 μ sec and 1 μ sec	10 μ sec to 10 sec	Time Interval* Generator	1 μ sec to 10 sec	Time Interval* Generator	0.1 μ sec to 10 sec
CODED OUTPUT FOR DRIVING DIGITAL RECORDER, ETC.	\$30.00 extra	Yes	Yes	Yes	Yes	Yes	Yes	Yes
COUNT CAPACITY (READOUT)	4 digit	7 digit	7 digit	6 digit	5 digit	7 digit	6 digit	7 digit
ACCURACY	± 1 count, $\pm$ oscillator stability							
OSCILLATOR STABILITY	1 part in 10 ⁶ per day	3 parts in 10 ⁷ per week	3 parts in 10 ⁷ per week	3 parts in 10 ⁶ per week	1 part in 10 ⁶ per day	3 parts in 10 ⁶ per week	1 part in 10 ⁶ per day	3 parts in 10 ⁷ per week
INPUT SENSITIVITY	0.25 v. rms	0.1 v. rms	0.2 v. rms	0.1 volt rms**				A & B—0.2 v. rms E—0.1 v. rms
INPUT IMPEDANCE	1 megohm, direct	1 megohm, ac coupled	1 megohm, ac or direct coupled	10 megohm, ac or direct coupled				A & B—1 megohm, ac or direct coupled E—1 megohm, ac coupled
TRIGGER SLOPES	Positive or Negative	Positive or negative						
CABINET DIMENSIONS	12" H x 8" W x 14" D	10 1/4" H x 20 3/4" W x 16 1/2" D (Rack Panel—8 3/4" x 19")						
APPROX. SHIPPING WT. LB.	30	60	60	60	50	60	50	70
PRICE: (F.O.B. FACTORY)	\$575.00	\$1675.00	\$1675.00	\$945.00	\$1295.00	\$1245.00	\$1445.00	\$1975.00

*Variable from 0.1 millisecond to 0.9999 sec in 0.1 millisecond increments and from 1 millisecond to 9.999 sec in 1 millisecond increments

**Modification for 5 millivolt sens. @ 5 cps available, \$50.00 extra



IN-LINE READOUT Model 5916

Large, illuminated, in-line in-plane figures reduce fatigue and error. Ideal for remote observation of data. It can connect directly to any 7000 series instrument or 5200 series portable. Presentation rate up to 15 per second; accepts binary voltages. Price (6-digit unit) \$775.00.

TRANSDUCERS—A large number of transducers especially designed for use with Berkeley counting, timing, and frequency measuring equipment is available. These include tachometer pickups, photocells, and light sources. Specifications and technical description on request.

See us at NEC...

For a close look at these advanced counting and timing instruments, be sure to visit Booths 241-244 at the NEC show in Chicago, October 7-9. Technical data and specifications are available from Beckman/Berkeley representatives or at the factory. Please address Dept. D9.

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Berkeley Division

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Berkeley's world-wide staff of factory trained engineering representatives work closely with our sales office and the customer. They help the customer set up newly-purchased equipment, acquaint personnel with its operation and application, and make sure that it stays in

operating order. The representative's job is not completed until he has "followed-up" to insure that the customer receives maximum use from his instruments. These men will be glad to give you personal assistance at any time. A list of Berkeley representatives follows.

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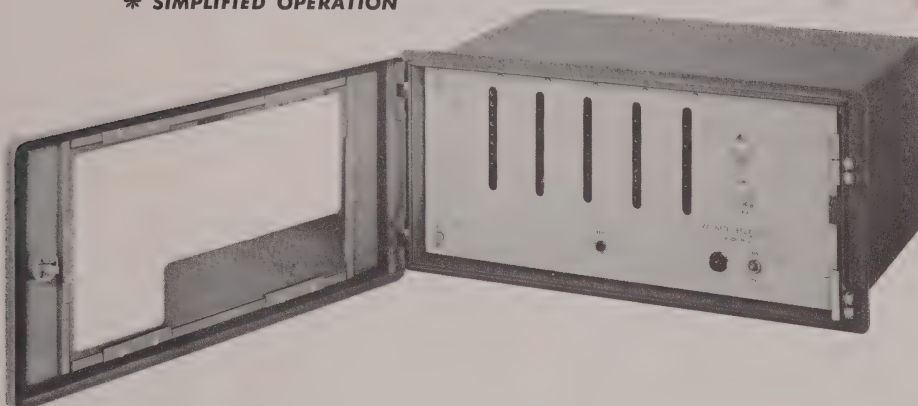
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 Royal Oak
 LI 8-4440

series 7600
 magnetic events-per-
 unit-time meters



FEATURES:

- * NO VACUUM TUBES EXCEPT IN POWER SUPPLY
- * CONTINUOUS-DUTY RELIABILITY
- * LONG COMPONENT LIFE
- * EXTERNAL RESET CIRCUIT
- * EASE OF SERVICING
- * SIMPLIFIED OPERATION

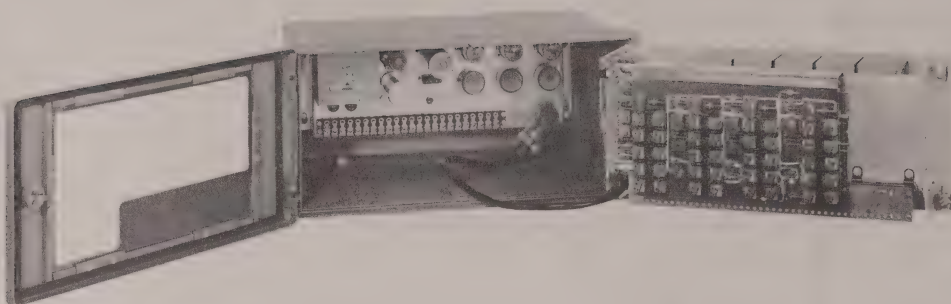


SPECIFICATIONS	Model 7650 Magnetic-Events-Per-Unit-Time Meter
Counting Rate:	0 to 40,000 per second
Count Capacity:	99,999
Accuracy:	± 1 count plus time base error
Time Bases:	0.1, 1 and 10 seconds ± 15 ppm from 15°-35° C, ± 55 ppm from 0°-50° C.
Sensitivity:	300 μ a, peak-to-peak into 10,000 ohms, 20 millihenries series load
Level Control Range:	± 1 milliampere
Display Time:	Adjustable 0.5 to 10 seconds (automatic reset). Display can be held indefinitely.
External Reset:	From relay contact closure.
Supply Voltage:	50-60 cps, switch selects taps at 105, 117 and 126 volts $\pm 10\%$ or 210, 222 and 231 volts $\pm 10\%$
Power Required:	Approx. 100 watts
R.F. Oscillators:	3 Type 6AU5 tubes
Dimensions:	18 $\frac{1}{8}$ " wide by 8-23/32" high by 14 $\frac{1}{8}$ " deep, for standard relay rack or wall mounting
Weight:	Approx. 55 lbs.
Price:	\$1495.00 f.o.b. Richmond, Calif.

Prices and specifications subject to change without notice.

EDITION OF SEPTEMBER 1956

Delivery as of January 15, 1957, 9 weeks.



A NEW CONCEPT

Both the Series 7600 magnetic events-per-unit-time meter and the Series 5800 preset controllers (see bulletin) represent another highly successful application of the Berkeley Ferristor*. This tiny, reliable magnetic coil replaces all the vacuum tubes in these instruments except those in the power supply. The versatile Ferristor performs all functions of vacuum tubes found in other counters—input amplifier, gate, time base, decimal counting unit, coincidence amplifier, and control circuit. It is not affected by high temperatures found in industrial installations. Consisting of a simple, wire-wound coil on a ferro-magnetic core, Ferristors are non-aging, immune to shock damage, vibration, moisture, and accidental overloading. They require no filament heaters and operate at extremely low current and voltage levels, generating almost no heat.

DESIGN FEATURES

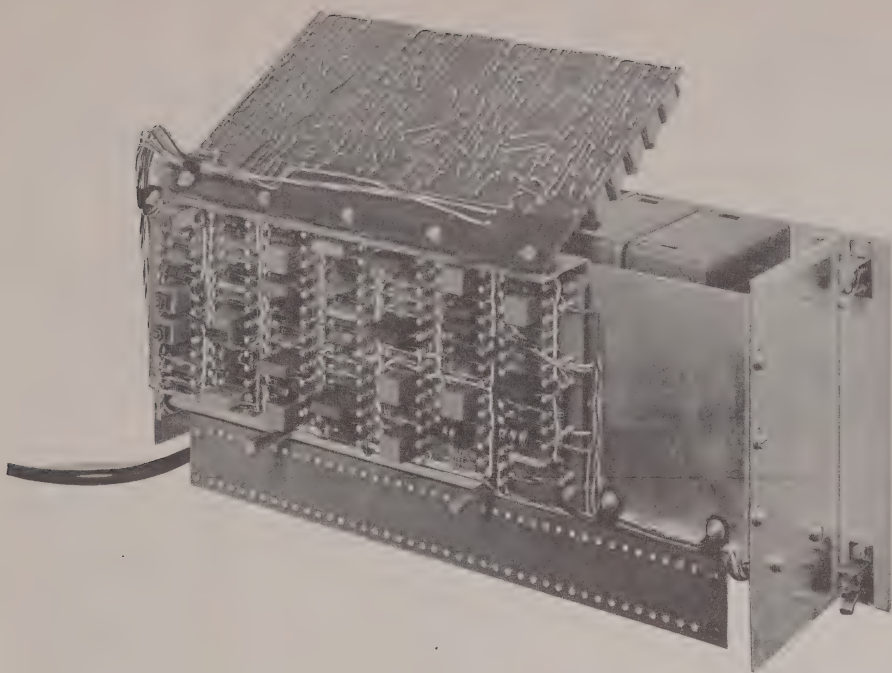
The unique construction of the instrument permits use of a dust-tight cabinet. It has a hinged front door which may be locked to prevent tampering by unauthorized personnel. The entire counting circuitry and front panel is an integral assembly mounted just behind the front door on loose-pin hinges. The entire instrument is thus

accessible in a matter of seconds to permit inspection and routine maintenance adjustments.

The power supply and input terminal strip are located at the rear of the cabinet, completely accessible when the front assembly is swung forward. The instrument will mount directly on a standard 19-inch width relay rack, or may be hung on wall brackets which are available. Accessibility to the input terminals, power input, and output circuits is made through standard electrical knock-out holes using commercial power wiring techniques.

The Ferristor obtains its power from an RF oscillator. In the Model 7650, three type 6AU5 vacuum tubes generate this RF power, but our continuing development program will soon permit the elimination of even these vacuum tubes.

If the RF oscillators fail, the fail-safe design of the instrument insures that counting will halt and false output signals will not be delivered. An important feature is the built-in testing circuit which allows operation of the instrument with reduced filament potential on the RF oscillators. Since the cathode emission of the oscillator tubes is of paramount interest, reducing the filament potential will show up a bad or marginal tube and its immediate replacement before the instrument fails will reduce the down-time of the instrument to practically zero.



DESCRIPTION:

The Magnetic EPUT Meter consists of an input amplifier, a gate which is opened and closed by a tuning-fork controlled time base, and a series of magnetic decade counting units.

The events occurring at an unknown rate produce input signals which are in turn amplified and properly shaped by the input circuit. These pulses are then admitted through the gate to a bank of five magnetic counting units. A signal from the time base opens the gate and keeps it open for an accurately controlled interval of time. It is closed by a second signal from the time base. The number of events that have occurred during that time interval are displayed on the illuminated panel of the magnetic counting units. If operated automatically, this result will be displayed from 0.5 to 10 seconds, and the instrument will then automatically recycle. If operated manually, the result will be displayed indefinitely until the "reset-start" button is depressed to obtain another reading.

The input amplifier of the Magnetic EPUT Meter will respond to currents as small as ± 3 milliamperes from DC to 40,000 cycles per second. The input impedance of the meter is equivalent to 10,000 ohms resistance in series

with an inductance of 20 millihenries, and up to one-half watt of power can be applied to the input of the unit without resultant damage to the circuit. A trigger level threshold adjustment provides input control over a range of ± 1 ma.

An important feature of the Magnetic EPUT Meter is the reliability of its time base. A 1 kc tuning fork controlled magnetic oscillator operates into a series of count-down magnetic frequency dividers which require no adjustment. Selectable gating intervals of 0.1, 1 and 10 seconds are provided, with accuracies of ± 15 parts per million over operating temperatures from 15 to 35 degrees centigrade and ± 55 parts per million from 0 to 50 degrees C. An adjustment range of ± 100 parts per million permits synchronization with a secondary frequency standard. This results in a complete time base unequalled for reliability, compactness, low power consumption and ruggedness.

An extremely useful feature of this instrument which finds wide industrial application is the external reset circuit. By placing the front panel display time control in the "infinite" position, the instrument will hold its display until reset either by manually depressing the reset button or making a contact closure to the external reset circuit

terminals available at the main terminal strip. The maximum time delay between reset and the start of a new counting period is 5 milliseconds.

Behind the dust-proof glassed front door is the front panel with five magnetic decade counting units each having illuminated panels numbered from 0 to 9. Also on this panel are the power "on-off" switch, power indicator lamp, manual reset button, display time control and switch, and time base selector switch providing a choice of 0.1, 1 and 10 second gate intervals and "count on-off" positions which permit the instrument to function as a straightforward counter under manual on-off control. By unlatching the front panel assembly and swinging it out on its hinges, access is made to the "test-operate" switch,

trigger level threshold control, time base oscillator trimmer adjustment, line voltage selector switch, and the terminal strip for signal input, power input, and external remote reset circuit.

APPLICATIONS:

Aircraft, automotive; jet or piston engine test cells; dynamometer test stands; laboratory or production tachometry systems, process control systems; data reduction systems; hydraulic and pneumatic servo testing; acceleration-deceleration determination; measurement of linear or centrifugal speeds, forces, strains; measurement of any optical, electrical, mechanical, or physical event occurring during a precise time interval.

Represented by
J. R. DANNEMILLER ASSOCIATES
 3955 Lee Road
 Cleveland 28, Ohio
 LO 1-4567

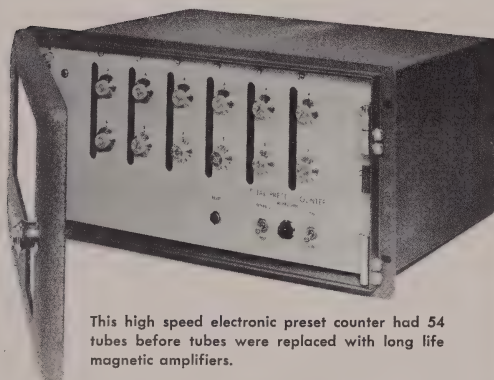
Dayton: 384 W. 1st St.
 Hemlock 0662

Detroit: 1204 North Woodward
 Royal Oak
 LI 8-4440

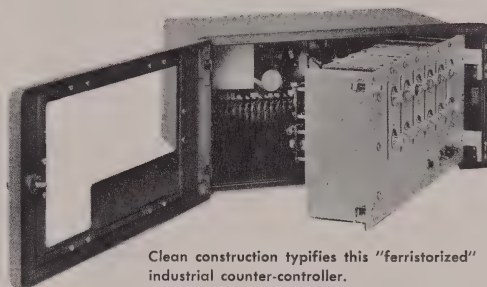
series 5800
magnetic dual
preset controllers

FEATURES:

- * **LONG COMPONENT LIFE**
- * **HIGH SPEED**
- * **EXTREME RELIABILITY**
- * **EASE OF SERVICING**
- * **MANUAL OR AUTOMATIC OPERATION**
- * **NO VACUUM TUBES EXCEPT IN POWER SUPPLY**



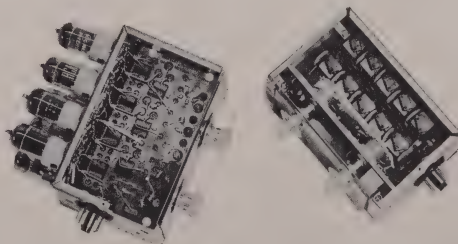
This high speed electronic preset counter had 54 tubes before tubes were replaced with long life magnetic amplifiers.



Clean construction typifies this "ferristorized" industrial counter-controller.



Servicing Berkeley's ferristorized instruments is easily accomplished by lifting sub-chassis off of hinge.



Ferristorized decimal counting unit presents a neat package along side the vacuum tube version. New unit is expected to last many times longer than vacuum tube DCU.

SPECIFICATIONS:

Model Number:	5844	5845	5846
Capacity:	1-9,999	1-99,999	1-999,999
Input Frequency:	From DC to 8,000 cycles per second		
Input Sensitivity:	100 microamperes		
Input Impedance:	10,000 ohms in series with 60 millihenries		
Level Control Range:	± 1 milliampere		
Output Information:	Control signals available independently for both channels		
Accuracy:	Absolute		
Operating modes:	Manual or automatic, recycling at higher count		
Outputs Available:	For each preset count: voltage change from approx. -5 to approx. -50 volts and DPDT relay; may be either pulse (adjustable 0.2-1 second) or hold between successive counts.		
Remote Reset:	From external contact closure		
Supply Voltage:	50-60 cps, switch selects taps at 105, 117, and 126 volts ±10% or 210, 222 and 231 volts ±15%		
Power Requirements:	117 volts, ±10%. Wattage varies from approximately 60 to 80 depending upon model		
Dimensions:	18 1/2" wide by 8-23/32" high by 13 1/2" deep overall, for standard relay rack or wall mounting.		
Weight:	50 lbs.		
Price:	\$1115 (Model 5844), \$1205 (Model 5845), \$1295 (Model 5846)		
Replacement Preset DCU Berkeley Model 736 Dual Preset Decimal Counting Unit \$130.00 each.			

All prices F.O.B. Richmond, California

Specifications Subject to Change Without Notice

THE MAGNETIC CONCEPT—Series 5800 Dual Preset Controllers the revolutionary Berkeley Ferristor* as a vacuum tube replacement. This guarantees continuous reliability and long component life, because Ferristors are non-aging. In addition, they are immune to shock damage, vibration, moisture, and accidental overloading. They require no filament heaters, operate at extremely low current and voltage levels, and generate almost no heat.

Consisting of a simple, wire-wound coils on a ferro-magnetic cores, Ferristors perform all functions of vacuum tubes found in other preset controllers. The Ferristor acts as an input amplifier, gate, time base, decimal counting unit, coincidence amplifier, and control circuit. High temperatures do not effect its operation.

The Ferristor obtains its power from an RF oscillator. In the Series 5800, two 6AU5 vacuum tubes generate this RF power.

BASIC DESIGN—The Dual Preset Controller consists of an input circuit, cascaded presettable Decimal Counting Units and two identical output channels. Events to be counted are applied to the input, amplified, and shaped. The incoming count is passed to the first of the cascaded Decimal Counting Units. At the first preset count, output information is derived from the first coincidence system and at the second preset count, from the second coincidence system. The decade counter used in the controller, a magnetic ring-of-ten, utilizes the ferro-resonant counting principle. Since this ring has ten discreet outputs, digit selection is accomplished by rotating a single pole-10 position switch to the desired setting. The outputs of all the decades are combined in a magnetic gating amplifier to give an output when the count agrees with switch settings.

Each output from the coincidence gate amplifiers is connected to a magnetic amplifier which drives a double pole double throw relay. With proper feed back elements this amplifier performs as a one shot or flip-flop, thus giving either momentary or holding closure of relay contacts.

Two modes of operation are possible: Manual and Automatic. When used manually, the controller gives the desired outputs at the preset numbers but must be manually instructed to repeat the cycle of operation. When used automatically, the controller gives the desired outputs at the preset numbers, resets itself to zero at the second number, and repeats the cycle indefinitely.

The control outputs can be turned off by a switch on the front panel. This allows setup modifications and check out before the controller actually energizes auxiliary equipment.

DESCRIPTION—The Berkeley Magnetic Dual Preset Controller—a high speed counting device—provides output information at any two counts within the maximum capacity of the unit. Any discreet physical change that can be converted into a changing current can be counted. Rotating the two switches adjacent to each decade presets the counter. Output signals, in the form of voltage pulses or relay openings or closures, can be used to control many processes automatically or sound an alarm prior to the second count.

Input signals pass through a magnetic amplifier to the cascaded magnetic Preset Decimal Counting Units. Two identical output channels, each consisting of a voltage pulse generator and a DPDT relay, are provided for each of the two preset numbers denoted as "count A" and "count B".

Several modes of operation are possible. With the "manual-

automatic" switch in the "Manual" position, the counter will count through "count A", at which time the "A" output channel will be energized. When "count B" is reached the "B" output channel will be energized and counting will continue. Depressing the manual reset button or providing a contact closure to the external reset circuit will reset the instrument at any time to the count of zero and initiate a new count. With the "manual-automatic" switch in the "automatic" position, output information will be obtained at the "A" and "B" counts as before, but at the "B" count, the instrument will automatically reset to the count of zero and begin a new cycle without losing a count.

Both the "A" and "B" output circuits may be individually selected to provide either "momentary" or "hold" types of output information. In the "momentary" condition, a voltage change (from about -5 volts to -50 volts) and a DPDT relay will operate for a period adjustable from about two-tenths to one second. The voltage pulse and all the DPDT relay contacts are available at the output terminal strip for both output channels.

In the "hold" condition the voltage change and relay operation for the "A" count will occur when the "A" count is reached and lock in this condition until the instrument is reset either manually or at the "B" count if operated automatically. The same action will result in the "B" output channel when its switch is placed in the "hold" position with manual reset. If operated with automatic reset, the "B" relay will revert to its original condition when the "B" count is reached a second time, thus providing a binary action.

A dust-proof cabinet protects the entire instrument. The hinged door opens to the front panel assembly holding the counting circuitry. Controls available here are the "A" and "B" preset count selector switches, the power on-off switch, output control on-off switch, and the manual reset button. A power indicator light is also included. The hinged front panel assembly swings out providing access to the "test-operate" switch, "manual-automatic" switch, "A momentary-hold" and "B momentary-hold" switches, trigger level adjustment, line voltage selector switch and the terminal strip for making connections to the input, power line source, external reset and output circuits.

APPLICATIONS: Control of counting, weighing, sorting, packaging, shearing, metal forming, coil winding equipment; cut-off of motors, turbines, jet engines at precise predetermined rev count or speed, computer timing, etc.

COIL WINDING—The Dual Preset Controller is ideally suited for control of high speed coil winding equipment. By use of a suitable pickup device, each turn added to the coil is registered as a count on the electronic control unit. When the first preset count is reached, the output information can be used to slow the coil winder so that when the second preset count is reached, there will be no overshoot due to the inertia of the winding unit.

AUTOMATIC PACKAGING—Because of its instantaneous clear to zero after reaching the preset count, the Dual Preset Controller is ideal as a continuous high speed packaging control unit. When used with the proper mechanical switching arrangement, this unit will give absolute accuracy. The double preset count allows the first count to be used as a warning signal before the final count. At warning, the operator can then prepare the equipment for the start of the next run.

*TRADEMARK

SORTING TO LENGTH—Flat sheets of all types can be sorted so that lengths falling outside the desired value are rejected. In this case, linear length is converted into voltage pulses by a suitable transducer and a kicker is actuated if the length falls out of the desired limits.

MOTOR CONTROL—If the preset controller is used in combination with an electronic digital rpm indicator, it can be used to control

motor speed between limits. In a similar manner, a combination such as this can be used to accurately control pressure temperature, frequency and many other phenomena.

This is but a partial list of the many uses of the Berkeley Dual Preset Controller. We invite your inquiries on specific applications of this unit.

summer, 1956



BERKELEY
SHORT FORM CATALOG
C 703

introducing
NEW BERKELEY
INSTRUMENTS and
COMPONENTS:

- FERRISTORS*
- DECIMAL COUNTING UNITS
- COUNTERS & PRESET COUNTERS
- TIME INTERVAL METERS
- EPUT* (Events-Per-Unit-Time) METERS
- UNIVERSAL EPUT* METERS
- FREQUENCY METERS
- NUCLEAR SCALERS, COUNT RATE METERS
- NUCLEAR AUTOMATIC SAMPLE COUNTERS

EASE* COMPUTERS

EASE* COMPUTER-QUALITY CONTROL SYSTEM
COMPONENTS

Systems for:

- DATA REDUCTION
- DATA HANDLING
- DATA LOGGING
- INDUSTRIAL MEASURING & RECORDING
- INDUSTRIAL PROCESS CONTROL

*Trademark

Berkeley division of Beckman Instruments Inc.

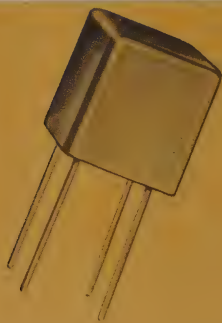
FERRISTORS* for Magnetic Amplifier and Counter Circuitry

FERRISTORS* are reliable, light weight, low-power replacements for tubes consisting of simple wire-wound coils on ferro-magnetic cores, and encapsulated in epoxy resin. They are immune to damage by shock, vibration, overload, humidity or temperature, and are ideally suited for industrial electronics where long-term reliability is an important factor.

In BERKELEY's new line of long-life counter-controllers, FERRISTORS* are used to perform all the functions of vacuum tubes in input amplifier, gate, time base, decimal counting unit, coincidence amplifier and control circuitry.

Complete technical data and prices will gladly be supplied on request.

Compact FERRISTOR* is encapsulated in 9/16" cube, with 4 pigtail leads.



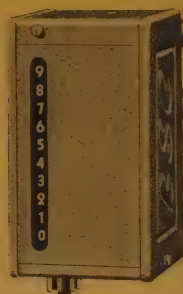
VACUUM TUBE Decimal Counting Units

All DCU's are designed for a four-line binary coded output to drive Berkeley digital printers, remote in-line readouts, or data converters. Counts are displayed in digital form on the illuminated front panel; units may be cascaded to provide any desired total count capacity, and plug into standard sockets.

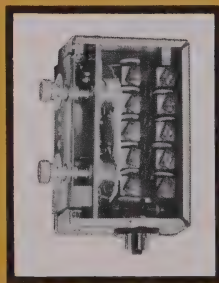
Model 705AH—100 kc max. count rate. Price, \$33.00.

Model 707AH—1 mc max. count rate. Price, \$95.00.

Model 711AH—2 mc max. count rate. Price, \$110.00. Designed to drive 713AH (200 kc count rate, \$75.00) which in turn drives the 705AH.



MAGNETIC Decimal Counting Units



Models 716-717 Magnetic DCU measure only 1 7/8" x 5 1/2" x 3 1/2". Model 716 has 10,000 cps max. counting rate; Model 717, 40,000 cps. Price (either model), \$110.00.

Model 736 Dual Preset Magnetic DCU produces output signal at any two pre-settable counts, handles up to 10,000 cps. Measures 1 7/8" x 5 1/2" x 3 1/2". Price, \$130.00.

Magnetic DCU's are capable of counting up to 40,000 pulses a second. Units may be cascaded indefinitely to achieve a counter of any capacity. Each DCU counts from 0 to 9, presenting an illuminated reading on the front panel.

Elimination of vacuum tubes permits an overall size reduction of up to 32% and a weight reduction of up to 59% over other units. Illustrated magnetic DCU's are plug-in units fitting standard octal sockets. Lower heat generation resulting from decreased power requirements permits more compact assembly than vacuum tube types.

VACUUM TUBE Preset Decimal Counting Units



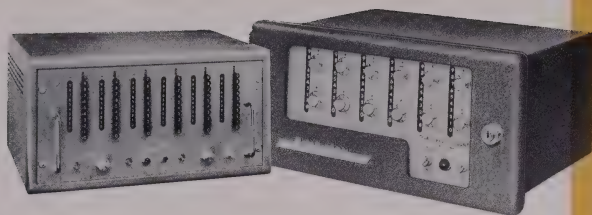
Model 730A Single Preset DCU produces output pulse at any single preset count. Price, \$65.00.

Model 732A Dual Preset DCU produces output pulses at any two preset counts. Price, \$75.00.

Berkeley Single and Dual Preset Counters count and display information at rates to 40,000 cps, and produce output pulses at any preset total count (Model 730A) or any two preset counts (Model 732). Output pulses will operate relays, audible or visual signals, solenoids, etc.

*Trademark

PRESET COUNTER-CONTROLLERS



Count at rates to 40,000 cps, produce output signals at any desired preset total (or any two preset counts with dual preset models). Operate on input pulse of ± 1 volt peak, or more. Instantaneous reset to zero after final count. Reliable, simple to operate. Available in 2,3,4,5 and 6-digit capacities. Long-life magnetic Model 5840 dual preset features FERRISTOR* circuitry for continuous-duty reliability.

Series 5420 single preset models range in price from \$435.00 for 2-digit capacity to \$740.00 for 6-digit capacity. Dual preset Series 5440 range from \$560.00 (2-digit) to \$840.00 (6-digit).

Series 5840 long-life magnetic dual preset counter features FERRISTORIZED* circuitry; 6-digit, Model 5846, \$1,295.00.

TIME INTERVAL METERS



Model 7250 Berkeley Time Interval Meters provide a direct, digital reading of elapsed time between any two events, or the duration of a single event, in microsecond (Model 7260) or 10-microsecond increments.

Any occurrences that can be changed to varying voltages may be so timed. Both models may be standardized against WWV or other external standards, and have connections for driving digital printers or data converters. Provisions are also made to measure period of input signals or use as a high-speed electronic counter or frequency ratio meter.

APPLICATIONS

Timing of relays, shutters, solenoids, controls; ballistics research; measurement of viscosity; elasticity, velocity; accurate low frequency and period measurements; calibration of pulse generators, precision phase measurements, frequency ratio measurements, etc.

BRIEF SPECIFICATIONS	Model 7250	Model 7260
Range:	10 μ sec to 1 sec	1 μ sec to 1 sec
Accuracy:	$\pm 10 \mu$ sec, ± 1 part in 10^5	$\pm 1 \mu$ sec, ± 1 part in 10^5
Input Requirements:	0.1 v rms, 10 megohms, ac or dc-coupled	
Display Time:	Adjustable, 0.1 to 5 seconds (automatic reset) Manual reset also provided.	
Price: (f.o.b. factory)	\$595.00	\$830.00

EPUT* (Events-Per-Unit-Time) METERS

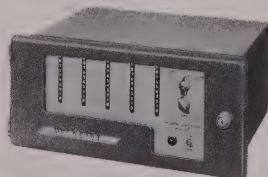


APPLICATIONS

Precision tachometry; measurement of pressure, flow, temperature, viscosity, velocity, frequency, frequency period; process control or data reduction systems; calibration of frequency generating equipment; measurement of any electrical, mechanical, optical or other physical event occurring during a precise time interval.

Berkeley EPUT* Meters automatically count and display the number of events that occur during a precise time interval. Events may be any physical occurrences that can be represented by changing voltages occurring either regularly or at random at rates to 1,000,000 per second, depending on model.

7000 Series units may be used to measure frequency or period, and also as high speed electronic counters with manual on-off control.



Model 7650 Long-Life Magnetic EPUT* Meter

BRIEF SPECIFICATIONS

	Model 7150	Model 7160	Model 7650
Count Capacity:	5 digits	6 digits	5 digits
Count Rate:	0 cps to 100 kc	0 cps to 1 mc	0-40,000 cps
Time Bases: (decade steps)	10 μ sec to 1 sec	1 μ sec to 1 sec	0.1 to 10 sec
Price:	\$775.00	\$995.00	\$1,495.00

Performs the same function as models described above. Employs Berkeley FERRISTORS* in all critical circuits to assure continuous-duty reliability. Ideally suited to industrial test applications such as jet and piston-engine test cells, etc. Has digital "count-down" time base for precise gating; no adjustment of time base required.

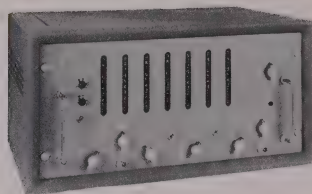
*Trademark

APPLICATIONS

Counting, time interval, EPUT* measurements for precision tachometry, measurement of pressure, flow, frequency, velocity, viscosity, elasticity; timing relay, shutter action, etc.
Measurement of unknown frequencies, frequency ratios, periods, etc.

BRIEF SPECIFICATIONS

	Model 7350	Model 7360
Ranges-Frequency:	0 cps to 100 kc	0 cps to 1 mc
Time Interval:	10 μ sec to 10 ⁶ sec	1 μ sec to 10 ⁶ sec
Period:	0 cps to 100 kc	0 cps to 1 mc
Time Bases:	10 μ sec to 10 sec	1 μ sec to 10 sec
Price:	\$890.00	\$1,175.00



These truly universal instruments combine high-speed electronic counting with a precision time base in multi-purpose circuitry. They function as counters, timers, time-interval meters, EPUT* meters, frequency, frequency ratio or period meters, or as secondary frequency standards.



Frequency Meters and Frequency Measurement Systems

Basic instrument is the Model 5571, capable of measuring frequencies from 0 cps to 42 mc. Addition of the Model 5580 UHF-VHF converter and suitable plug-ins extends the range to 515 mc; Model 5582B VHF converter with plug-ins extends the range to 1,000 mc. Results are displayed in direct-reading digital form. Unit will drive a Model 1452 digital printer to provide a complete frequency logging system in which results are printed on standard adding machine tape. Model 5571 is also a Universal EPUT* and Timer with same specifications as Model 7360.

Model 5571 with 5580 converter and 5580 series plug-ins for frequencies to 515 mc. Model 5571 price, \$1,745.00. Model 5580 converter, \$300.00; 5581 series plug-ins, \$100 to \$150.00 each. All are FCC-approved.

Complete frequency logging system for frequencies to 1,000 mc. Model 5571 (with 5582B converter and plug-ins), drives Model 1452 digital printer to record results automatically on adding machine tape. 5590 WWV receiver and 5585 2 to 42 mc Selective Amplifier also shown.

BERKELEY DOUBLE PULSE GENERATORS

Produce paired or single pulses. Pulse amplitude, width, polarity, repetition rate and pulse-to-pulse spacing are independently adjustable. Outputs may be mixed internally or externally. Model 903 (\$440.00) can be driven externally by pulses; Model 4904 (\$595.00) by pulses or sine wave generators.



BERKELEY TEST ACCESSORIES

TACHOMETER PICKUPS

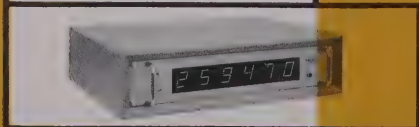
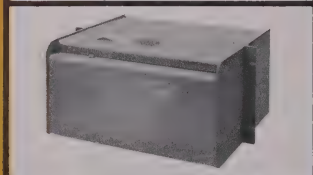
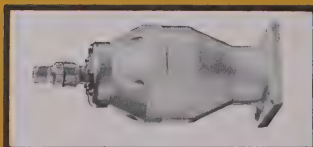
Consist of magnetic pickup and toothed tachometer gear (number of teeth optional). Offered in 3 types, also explosion proof. Photo-cell pickups and light sources also available.

MODEL 1452 DIGITAL PRINTER

Connects directly to any Berkeley 5510, 5571 or 7000 Series instrument, prints data in digital form on standard adding machine tape. May be modified to print "Time" or "Code" information simultaneously with data. Rack mounted; available in up to 8 digits. Price (6 digit), \$850.00.

MODEL 5916 IN-LINE READOUT

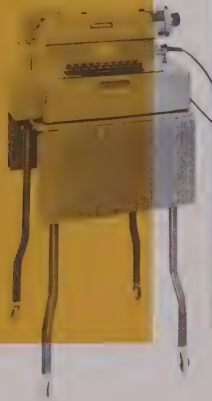
Large, illuminated in-line IN-PLANE figures reduce fatigue and error. Ideal for remote observation of data. Connects directly to any Berkeley 5510, 5571 or 7000 Series instrument. Price (6 digit) \$775.00.



*Trademark

FIELDS OF ACTIVE PARTICIPATION

1. High speed, high accuracy analog-to-digital and digital-to-analog conversion
2. Digital timing and recording systems
3. Automatic logging systems (static or dynamic)
4. High speed telemetered data handling
5. Industrial tachometry-fuel flow measuring and recording systems
6. Complete closed loop analog control systems
7. Industrial batching-sorting control systems
8. Automatic nuclear sampling and recording systems
9. Special-purpose digital computers
10. General-purpose data handling and data reduction systems
11. Machine tool control



Telemetered Data Handling Systems

Among recent systems developed by Berkeley is one capable of high speed measurement and recording of FM and FM-commutated data. Analog data represented by a frequency-modulated signal is continuously decommutated, measured, operated on, and the corrected data presented at the output in both digital and analog form. Features include:

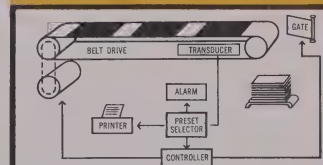
1. Compensation for tape wow and flutter
2. Compensation for transducer drifts
3. Accuracy to $\pm 0.1\%$
4. High speed digital computation

Other systems can be provided for pulse code telemetering, featuring an airborne electronic commutator, a reliable airborne magnetic analog-to-digital converter, and on-line computation of data on the ground.

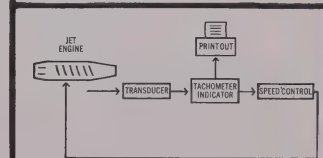
Standard component blocks have also been developed for use in telemetering systems handling Pulse-Width and Pulse-Amplitude modulated signals.

Typical Systems

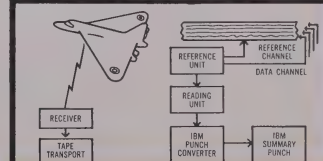
1. Steel mill counter-controller. Counts, stocks, batches and records steel sheets. Eliminates costly give-away.
2. Jet engine tachometer controller. Measures high rotational speeds to an accuracy of 0.001%.
3. Tape-data-to-punch-card system. Reduces multiple channels of magnetic tape data to punch cards; does in 30 minutes a task that formerly required 80 hours.



1



2



3

Model 5692 Digital Flow Indicator

Automatic Logging Systems

Berkeley division has long been actively engaged in the investigation and manufacture of complete data handling systems. The approach used is to accumulate standard blocks which can be assembled into a complete system to meet individual customer requirements.

Both dynamic and static logging systems can be provided for the sampling and recording of temperature, pressure, RPM, fuel flow, position and other analog quantities. Speed of sampling may range from 1 sample per second to 40,000 samples per second with accuracies to $\pm 0.1\%$. Inputs can be from thermocouples, strain gages, or digital transducers.

Typical systems include either mechanical or electronic commutator, analog to digital converter, programmer, output storage unit and recording device.

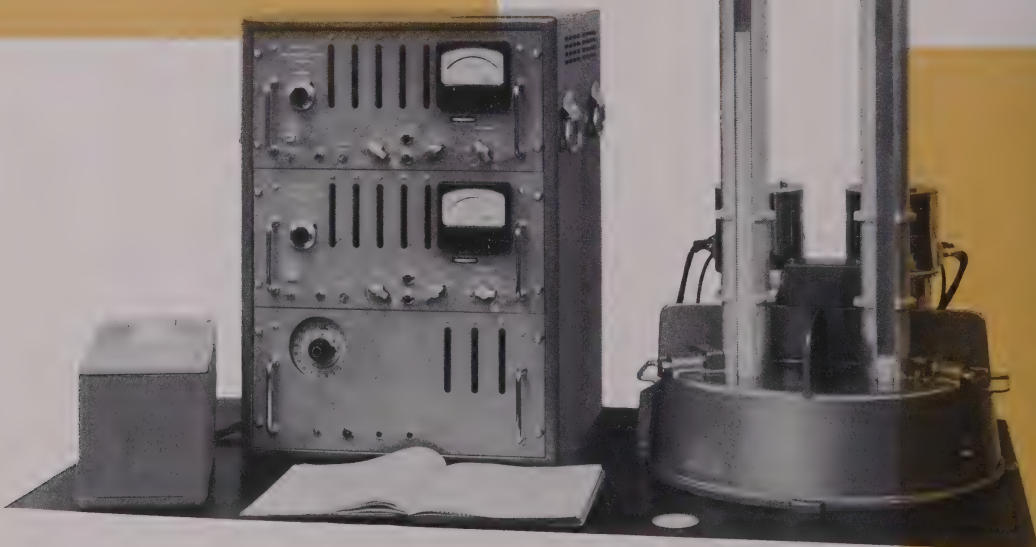
Timing and Recording Systems

With the use of modified digital time interval meters and digital recorders, as manufactured by Berkeley division, complete industrial timing and recording systems can be manufactured to meet individual requirements.

Timing accuracies to $\pm .1$ microsecond can be provided with recordings on standard adding machine tape, paper punched tape, magnetic tape, IBM cards, typewriter, teletype machine, by the use of Berkeley data reduction converters which operate with all Berkeley instruments.



Model 5692 Digital Flow Indicator provides four-digit presentation, reading directly in pounds or gallons per hour either as a flow indicator or totalizing meter. Works with any digital flow meter.



Automatic Nuclear Sample Counter automatically counts and records data on printed tape; handles up to 250 samples. Berkeley's complete line of Nuclear instruments includes decimal scalars, count rate meters, scintillation counting systems.

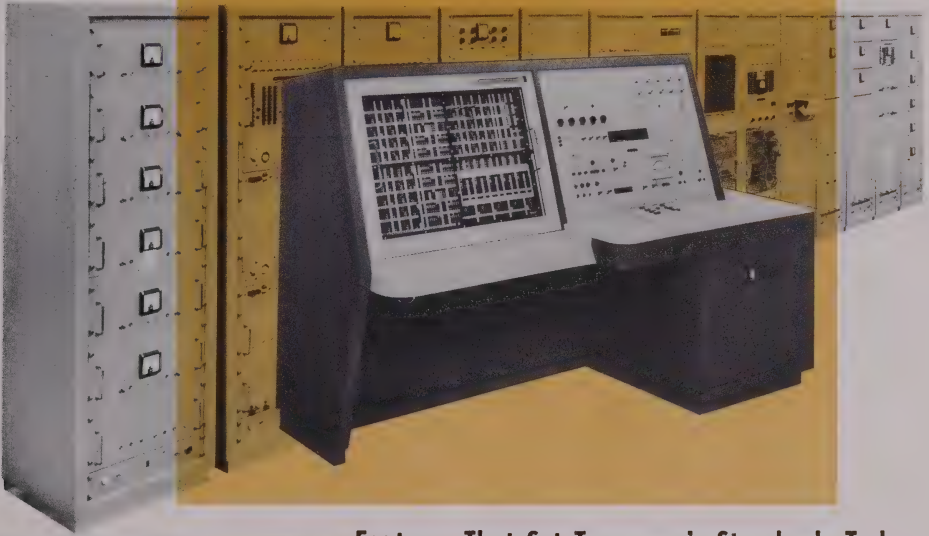
BERKELEY EASE* COMPUTERS

New EASE* 1200 Series Analog Computers

The EASE* 1200 series represents maximum convenience and accuracy in large scale analog computers, including completely automatic and/or remote control of all attenuator settings by a serial type keyboard and/or punched tape input. In the EASE* 1200, the user finds tomorrow's computer today.

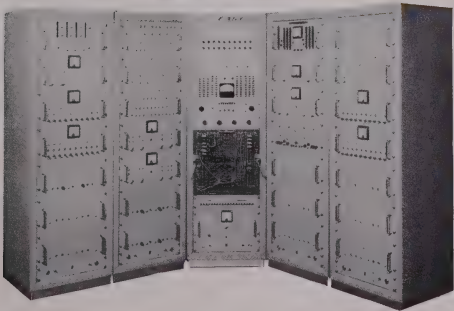
The patch bay system is all new, featuring complete shielding and insulation to eliminate accidental shorting of patch cords. The patch bay has sufficient capacity (3600 terminals) to interconnect more than:

- 100 dc amplifiers
- 16 servos
- 350 keyboard-controlled attenuators
- 30 electronic multipliers
- 250 spare terminals
- Adequate trunk lines and terminals for limiters, biases, etc.



Features That Set Tomorrow's Standards Today

1. High accuracy and stability
2. Complete keyboard control of all problem parameters including initial conditions and coefficients
3. Automatic punched tape or card attenuator setting
4. Complete and automatic recording of all problem parameters
5. Built-in problem checking system
6. Built-in 6-channel chart recorder
7. Completely shielded patch cord and patch board system
8. "Human engineered" centralized console design
9. Instantaneous and "stored" overload indication
10. Unitized design for complete flexibility and future expansion
11. Modular construction

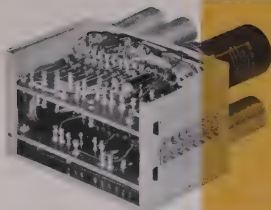


MEDIUM-PRICED — .05% accuracy; includes pushbutton control unit to handle up to 100 servo-set pots, 50 amplifiers, 16 electronic multipliers. Various combinations of function generators, servo multipliers and special equipment available.

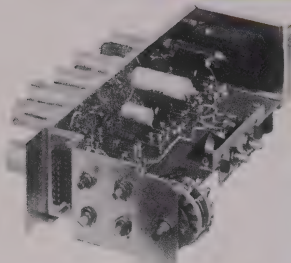


LOW-PRICED — 1% accuracy; as shown includes 10 amplifiers (stabilized or unstabilized), 16 coefficient pots, 10 initial condition voltages for integrators. Model 1031 patch board accommodates up to 42 decade stepping resistors and multiturn pots, 30 amplifiers, for future expansion.

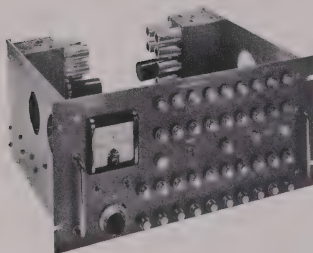
*Trademark



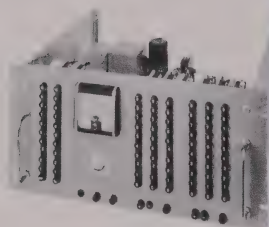
Model 1048 DC Amplifier...a chopper-stabilized operational amplifier with open loop gain in excess of 10^6 and extremely low drift. Adaptable to many computing functions where accuracy and stability are important such as amplification, inversion, addition or integration. These amplifiers have also been used as isolation devices, as highly stable recorder drives, as difference amplifiers, etc.



Model 1056B Electronic Multiplier...a highly stable device with less than 0.2% drift in any 8-hour period, static accuracy of 0.2% of full scale, and frequency response flat within $\frac{1}{2}$ db to 500 cps. Useful wherever accurate, fast multiplication of dc voltages is desired at reasonable cost.



Model 1073 Function Generator...a self-contained diode function generator requiring no patching or external connections. Approximates non-linear function by 20 straight-line segments, using locking-type knobs for adjustments, accurate null-reading meters, and precision potentiometer. Can be used for linearizing outputs of transducers or non-linear metering devices, to compensate for non-linear values or transfer characteristics in process control, or for simulating characteristic behaviour of physical systems.



Automatic Setup Function Generator...completely self contained diode function generator; one control unit sets up to 10 function generators automatically. Can be used in combination with a Berkeley servo as a "mapreader" to generate functions of two variables.

*Trademark

Complete technical data price and delivery information on any Berkeley product will gladly be supplied on request. Call your nearest Berkeley representative (listed below), or write us now; please address Dep't G13.

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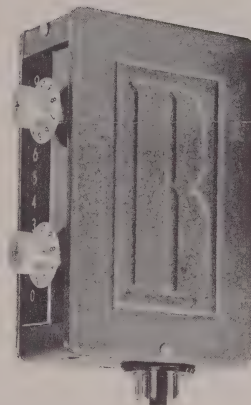
division of Beckman Instruments Inc.
RICHMOND 3, CALIFORNIA
PHONE: LANDSCAPE 6-7730

magnetic decimal counting units



models 716 - 717 magnetic dcu

model 736 dual preset magnetic dcu



Specifications	Models 716 - 717	Model 736
Power Input	165V rms $\pm 10\%$ @ 1.7 mc 1.5 watts per DCU Bias 300V @ 3 ma $\pm 10\%$	165V rms $\pm 10\%$ @ 1.7 mc 1.5 watts per decade Bias 300V @ 3 ma $\pm 10\%$
Pulse Input	20 ma peak Duration = 2 to 12 μ sec. Rise time = 5 μ sec. approx.	20 ma peak Duration = 2 to 12 μ sec. Rise time = 3 μ sec. approx.
Output Characteristics	$\pm 30V$ Max. output current = 3 ma Rise time = 5 μ sec. approx.	$\pm 30V$; maximum output current = 2 ma Rise time = 5 μ sec. approx.
Count Indication	Direct reading decimal presentation	Direct reading decimal presentation
Max. Count, Rate	Model 716—10,000 cps Model 717—40,000 cps	10,000 cps
Resolution of Paired Pulses	Model 716—100 μ sec. Model 717—25 μ sec.	100 μ sec.
Reset to Zero	$\pm 20V \pm 20\%$ into 4,000 ohms Duration > 30 μ sec.	$\pm 20V \pm 20\%$ into 4,000 ohms Duration > 30 μ sec.
Connector	Standard Octal Plug	Standard Octal Plug
Dimensions	1 $\frac{7}{8}$ " x 5 $\frac{1}{2}$ " x 3 $\frac{1}{2}$ "	1 $\frac{7}{8}$ " x 5 $\frac{1}{2}$ " x 3 $\frac{1}{2}$ "
Weight	13 oz.	1 lb.
Tubes	None	None
Price	\$110.00	\$130.00
F.O.B. Richmond, California Prices, specifications subject to change without notice		
EDITION OF JANUARY 1956		

DESCRIPTION

New Berkeley magnetic decimal counting units (DCU's), Models 716, 717 and 736, are long life, direct reading, high-speed counting devices using tiny magnetic amplifiers (Ferriators*) as the basic component rather than vacuum tubes. They were designed for industrial counting and control applications requiring the utmost in reliability.

Magnetic DCU's are capable of counting up to 40,000 pulses a second. Units may be cascaded indefinitely to achieve a counter of any capacity. Each DUC counts from 0 to 9 continuously presenting an illuminated reading on the front panel. Worthy of note is the reading ease gained by use of larger panel numbers and lights approximately two and one-half times brighter than comparable vacuum tube type decades.

Elimination of vacuum tubes permits an overall size reduction of up to 32% and a weight reduction of up to 59% over other units. Illustrated magnetic DCU's are plug-in units fitting standard octal sockets. Lower heat generation resulting from decreased power requirements permits more compact assembly than vacuum tube types.

CIRCUITRY

Magnetic DCU's are true ring-of-ten type counters that use ten ferro-resonant bistable elements so connected that each incoming pulse advances the count one position on the ring. Each of the ten discrete outputs is connected to a neon indicator light. In the Model 736 Dual Preset Magnetic DCU, output pulses are also connected to ten-position selector switches from which two preselectable outputs may be obtained. Accordingly, by cascading Model 736's and adding proper gating circuitry, two independent outputs at any two preselected counts between one and the full capacity of the instrument may be obtained.

In all units output from the number "nine" element is demodulated and brought out to provide a gating voltage for parallel gated counter operation. This output may be differentiated and the leading edge used to drive the next DCU through an intermediate magnetic amplifier.

represented by

J. R. DANNEMILLER ASSOCIATES

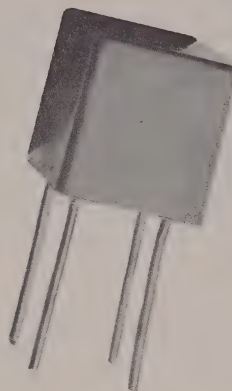
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18 WEST MONUMENT AVE.
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2980 W. DAVISON AVE.
Phone: TOWnsend 9-3141

ferristors
stock no. 41-1, 2,
11, 12 and 13



*short lived vacuum tube and long life magnetic component which
replaces tubes in industrial counter-controllers*

SPECIFICATIONS

FERRISTORS FOR MAGNETIC AMPLIFIER AND COUNTER CIRCUITRY

Stock No.	41-11	41-12	41-13	41-1	41-2
Control Winding Inductance (Millihenries)	2.5 (unsaturated) 1 (saturated)	10 (unsaturated) 5 (saturated)	40 (unsaturated) 18 (saturated)	25 (unsaturated) 16 (saturated)	6 (unsaturated) 3 (saturated)
Control Winding Resistance (Ohms)	80	220	680	320	150
Controlled Winding Inductance (Microhenries) (Measured at 1.7 mc.)	120 (unsaturated) 6 (saturated)			50 (unsaturated) 7 (saturated)	40 (unsaturated) 6 (saturated)
Controlled Winding Resistance (Ohms)	4.5			8.5	8
Max. Carrier Current through Controlled Winding	100 Ma				
Max. Applied Carrier Voltage at RF Supply (for bistability with 500 uuf)	35V RMS @ 10 mc.			7V RMS @ 1.7 mc.	
Dimensions	$\frac{3}{16}$ " Cube with 4 pigtail leads			EDITION OF JANUARY 1956	

Note: Tolerance all values $\pm 10\%$

Ferristors* are reliable, lightweight, low-power replacements for vacuum tubes. Affected by neither humidity nor temperature, this sturdy epoxy resin encapsulated component is ideally suited for industrial electronics. In Berkeley's new line of long life counter-controllers, Ferristors are used to perform all the functions of vacuum tubes: input amplifier, gate, time base, decimal counting unit, coincidence amplifier, and control circuitry. Consisting of a simple wirewound coil on a ferro-magnetic core, ferristors are immune to damage from shock, vibration, accidental overload.

Berkeley manufactures two general classes of Ferristors:

1. Stock No. 41-11, 12, 13 for high speed magnetic amplifier application.
2. Stock No. 41-1, 2 for counting circuit use.

Every member of the amplifier series is a miniature saturable reactor. One member differs from the other only in the number of turns on the control winding. The controlled winding bears the same number of turns throughout. They are designed to work with carriers in the 1-10 mc frequency range. Higher frequencies are preferred for greater gain and power handling capabilities.

Many different types of magnetic amplifier circuits may be generated from Ferristors. Figure 1 is a plot of inductance

(L) vs. control current (I_c). A typical amplifier circuit and its transfer characteristics are shown in Figure 2. An output either in or out of phase with the input can be obtained by merely reversing the rectifier diode. The proper operating point on the transfer characteristic is chosen by using a current bias through the control winding or a small permanent magnet.

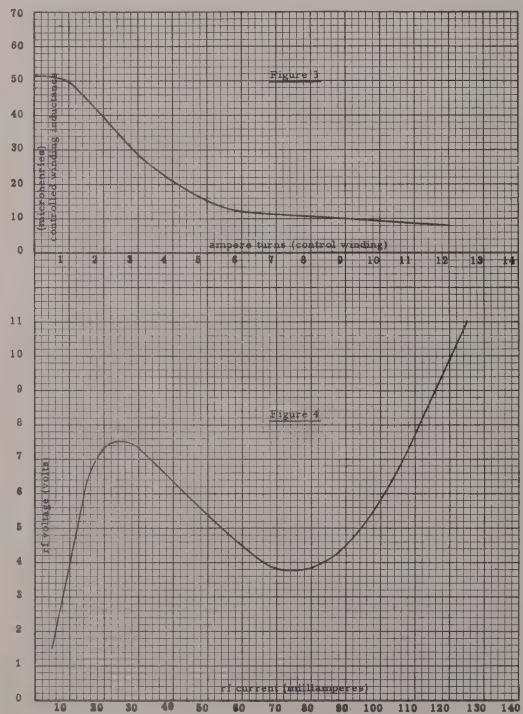
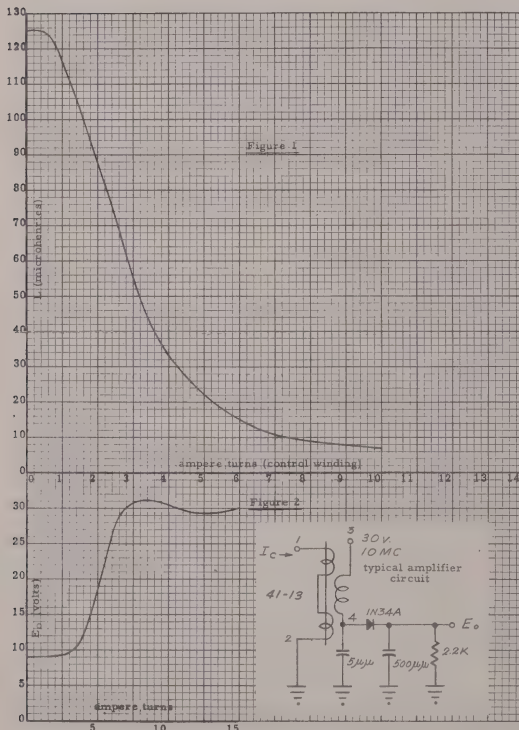
The other series is designed for ferro-resonant counter applications. Combined with the proper size capacitor and connected to an appropriate alternating current source, the 41-1 forms a bistable circuit whose two stable states are:

1. an inductive circuit with low circulating current and
2. a near resonance (slightly capacitive) circuit with high circulating current.

With suitable circuitry, these bistable components function as flip-flops or ring-of-N type counters where N may have any integral value from two to twenty.

The 41-2 is similar to the 41-1. A saturable reactor with fewer turns on the control winding and slightly lower inductance on the controlled winding, it is designed for triggering ring-of-ten type counters.

Figures 3 and 4 are characteristic curves for this series.



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 Cleveland 28, Ohio
 LO 1-4567

Dayton: 384 W. 1st St.
 Hemlock 0662

Detroit: 2980 W. Davison Ave.
 TO 9-3141

berkeley series 5910 in-line indicators



- * EASY READABILITY FROM ANY ANGLE
- * REDUCES FATIGUE
- * GREATER ACCURACY THROUGH FEWER READING ERRORS
- * SPEEDS MEASUREMENTS
- * IN-LINE, IN-PLANE PRESENTATION
- * HIGH RELIABILITY, LOW MAINTENANCE

SPECIFICATIONS	5914	5915	5916
Number of digits	4	5	6
Digit size	$\frac{3}{4} \times 1\frac{1}{4}$ inches		
Dimensions (overall)	$5\frac{1}{2}$ H x $20\frac{3}{4}$ W x 17 D.		
Shipping Weight	34 lbs.	35 lbs.	36 lbs.
Power Requirements	117 Volts AC $\pm$ 10%, 50-60 cps, 125 watts		
Operating Speed	Up to 15 presentations per second		
Input Signals	Binary voltages from counting instruments		
Price	\$610.00	\$695.00	\$775.00
Modification R (less Cabinet)	$3\frac{1}{2}$ x 19 panel x 17 deep. less \$15.00		
Model 5901	Replacement Digit Module \$110.00		

Modification Kits for adapting older Berkeley instruments for use with in-line indicators:

P-4 Kit, for Models 5556, 500-B. Use Model 5914 In-line	\$205.00
P-5 Kit, for Models 554, 510, 5500. Use Model 5915 In-line	\$245.00
P-6 Kit, for Models 5558, 5570. Use Model 5916 In-line	\$345.00

DESCRIPTION

Reading an electronic counter can often be a difficult job. Scanning up and down the tiny numbers of decimal counting units to determine which ones are lighted and then remembering them in the proper sequence is time-consuming and tiring. Readings from a distance are impossible.

Now Berkeley, the leader in the field of electronic counting instruments, brings you the first practical solution to this problem—a truly in-line, **IN-PLANE** readout indicator. Large, easy-to-read numbers reduce operator fatigue and provide greater accuracy through fewer readings errors. Easily read from across the room or in a high ambient light level, Berkeley in-line indicators retain their readings while the counter accumulates new data. Then only those digits which differ from the previous reading will change—*automatically!* Making a reading while accumulating data for the next reading allows a sharp reduction in instrument display time, speeds measurements, and makes possible more samples per unit time than ever before without automatic logging equipment. Presentations at rates up to 15 per second can be achieved—higher than the practical limit of visual readability.

One Plane Presentation. Intended primarily as an accessory for counting instruments, each digit of the Series 5910 uses a novel arrangement of seven lighted bars or segments to form any number from zero to nine. Unlike in-line readouts using stacked illuminated lucite plates, each engraved with a single number, or glow tubes having an arrangement of stacked wires which are formed into numbers, the seven segments of the Berkeley indicator present all the numbers *in one plane*. There is no masking or cluttering of numbers caused by unused elements "in the way". Numbers are always of uniform color and intensity, and can be read from virtually any angle.

Optional Rack Mounting. Normally supplied in an attractive, lightweight blue wrinkle finish aluminum cabinet, readouts may also be mounted in a standard 19-inch relay rack (3½ inches high). The display units can be placed up to 200 feet from the basic instrument or mounted in explosion-proof housings meeting Class I Group D requirements. A

6-foot cable with connector is supplied for connection to the basic counting instrument.

The Model 5915 5-digit In-line can be used directly with the Berkeley Models 7150, 7250, and 7350.

The Model 5916 6-digit In-line can be used directly with the Berkeley Models 7160, 7260, 7360, 5510 and 5571.

BASIC DESIGN

Each "digit" consists of a plug-in module formed by a printed circuit board, two tubes, four printed circuit relays and a printed circuit display panel. The relays, the finest obtainable using palladium contacts, are guaranteed for fifty million operations. Any relay can be changed without damaging the printed circuit board or the relay coils can be changed without removing the relays. The display panel uses seven miniature "grain of wheat" lamps operating at reduced voltage for long life and mounted in screw-type sockets for ease of replacement. Modules are firmly anchored and supported to withstand shock and vibration.

The complete indicator contains from four to six of these modules plus a power supply and latching control circuitry. The front panel carries a power switch, pilot lamp, number display units, an indicator lamp which flashes briefly for each new reading, and a push-button type switch. Depressing this switch disables the latching circuitry so that the counting units of the basic instrument can be followed while they are counting.

Input information to each of the digits is supplied in the form of four binary voltages with values of zero and minus fifteen volts or greater from electronic decimal counting units using 1-2-2-4 weighting. All the newer Berkeley instruments, such as the 7000-series instruments, 5510, 5571, etc., supply these voltages from a connector at the rear. Most older Berkeley instruments can be modified. The latching signal, taken from the gate of the counting instrument, changes from zero to minus twenty or more volts. All digits read out the electronic counter simultaneously.



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SILVER SPRING, MARYLAND

WINSTON-SALEM, NO. CAROLINA
Murphy & Cota
35 Burke St.

1452 digital recorder

FEATURES

- Printer and Scanner in Single Compact Unit
- No duplication of Counting Units
- Automatically and Permanently Records Information from:
 - Frequency Meters
 - Time Interval Meters
 - EPUT Meters
 - Electronic Counters
 - Scalers

SPECIFICATIONS

Recording and Indicating Capacity	6 digits standard. 8 digits on special order	
Maximum Cycling Rate	1 printout every 0.85 seconds for 6 digits	
Counting Period Range Accuracy	Determined by the characteristics of the basic counting instrument	
Visual Display Time	Controlled by counting instrument	
Power Requirements	105-130 volts, 50-60 cycles, approx. 125 w	
Input Requirements	Four-line code from the basic counting unit	
Cable Length	6 feet	
Dimensions	Approx. 19" wide x 10½" high x 14" deep	
Weight	60 lbs.	
Price		
Model 1452	\$850.00	
Digital Recorder	\$ 25.00 (Accordion type tape with feed and storage box)	
Modification A		
Modification R	\$110.00 (Relay rack mounting)	
Note: To modify older Berkeley instruments for use with the Model 1452, the instrument should be returned to the factory.		
Modification at factory of equipment shipped in last 2 years	4 dcu units	\$170.00
	5 dcu units	\$195.00
	6 dcu units	\$250.00
Modification kit for field modification	4 dcu units (decades returned)	\$145.00
	5 dcu units (decades returned)	\$170.00
	6 dcu units (decades returned)	\$225.00
All Prices F.O.B. Richmond, Calif. Specifications subject to change		

DESCRIPTION

The Berkeley Digital Recorder Model 1452 provides a simple, reliable, yet inexpensive, means of converting electronic count information into printed form. This unit can be coupled directly to a Berkeley electronic counting device and will print sequentially in Arabic numerals on a standard adding machine tape, the total count accumulated by the basic instrument during each of its counting periods. The Model 1452 is ideal for long term stability checks, recording of transients or for making permanent printed record in digital control systems. Information that normally would have to be extracted visually and then remembered or written down by the operator is now printed automatically as a matter of permanent record. Thus we may increase the cycling rate several hundred percent and at the same time eliminate the possibility of human error.

The Berkeley Digital Recorder is designed to operate directly from Berkeley Events-Per-Unit-Time Meters, Time Interval Meters, Electronic Counters and Nuclear Scalers which have a 4-line binary code available from each decade. Most new Berkeley instruments have this 4-line code available and provision is made for direct connection to the Model 1452. Most Berkeley counting equipment now in the field can be adapted for such operation.

To facilitate the review of recorded data, folded adding machine tape can be employed. When long term stability runs are made using the folded tape, determination of the results of a specific point in the run can be easily found without unwinding a complete roll.

EDITION OF JANUARY 1956

BASIC DESIGN

The Model 1452 consists of a stepping switch, a relay matrix, control and interlock relays, a solenoid operated adding machine and a power supply. The 4-lined coded information is taken directly from each decade in the basic counting unit. This coded output is connected directly to the stepping switch in the Digital Recorder. At the end of the count the basic counter gives a readout command to the Digital Recorder. The stepping switch then scans the information in each Decimal Counting Unit in turn and applies this information through buffers to the relay matrix. The relay matrix is so designed that an actuating voltage will be applied to the same digit of the printer as is shown visually on the Decimal Counting Unit of the basic instrument. When all Decimal Counting Units have been scanned, a print command is given to the adding machine which in turn prints the information shown visually on the electronic counter.

The interlock circuits of the Digital Recorder are so designed that the electronic counter can not automatically clear the visual indication from its own Decimal Counting Units until after the print command has been given. Thus the information will never be cleared from the indicating units before a permanent record is made. Also, the next sample count can be made on the electronic counting device before the printing action is completed. The normal complete printing cycle is 0.85 sec. However, when using the Digital Recorder with an instrument such as the Universal Counter and Timer, it is

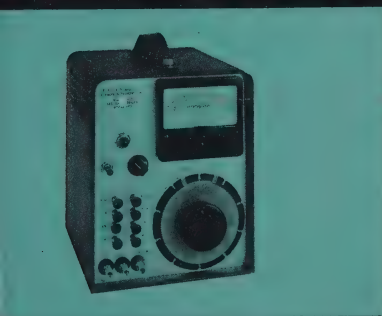
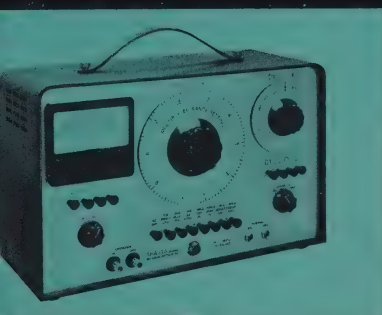
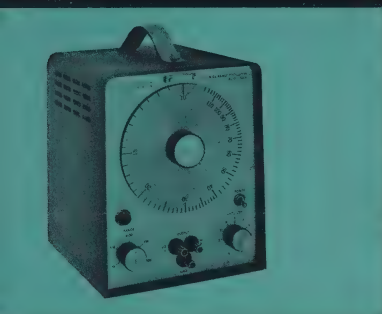
possible with a time base shorter than one second to obtain printed records at a rate greater than one per second.

In addition to count information, the Model 1452 can be modified to print "Time" or "Code" information on the same tape. With a standard 1452, two of the six digits are available for either "Time" or "Code" input. This information can be supplied by injecting two additional 4-line codes into the stepping switch and synchronizing the print code so that it follows the "Time" or "Code" digits. Further information on this special modification can be obtained from the factory.

OPERATION

There are two front panel controls on the Model 1452 Digital Recorder. These are the "On-Off" switch and the "Standby-Operate" switch.

In operation, the cable from the recorder is connected to the proper accessory socket of the electronic counter. The Digital Recorder is turned on and placed in the "Standby" position. The electronic counter is adjusted to obtain the desired operation. The "Standby-Operate" switch is thrown to the "Operate" position. A continuous chain of information will be printed if the electronic counter operates automatically or a single printed record will be obtained if the electronic counter operates manually. The "Standby-Operate" switch can also be used to hold the printing action until the physical quantity under test reaches stability.



QUALITY TEST INSTRUMENTS

designed
for the user

Shasta division of Beckman Instruments Inc.
P.O. BOX 296, STATION A, RICHMOND, CALIFORNIA

FEATURES

± 0.25% ACCURACY
TRUE RMS READING
EASY TO READ EXPANDED SCALE
DIRECT CONNECTION FOR 1 MA RECORDER
AVAILABLE IN EITHER PORTABLE OR
RACK MOUNTED FORM.

APPROXIMATE SPECIFICATIONS

Accuracy: ± 0.25% of input voltage
Voltage indicated: True rms
Voltage Range: 100-500 (or 50-250)
Frequency Range: 50-2,000 cps
Scale Range: 12 v. (smallest div. 0.2v)
Dimensions: 7 1/2" W x 8 1/2" H x 9 1/2" D
Price: \$360.00 (rack mount—\$400.00)



EASY-READING 6" METER

WIDE VOLTAGE AND DB RANGE: .001 TO
300 V, —60 TO +50 DB, FULL SCALE
WIDE FREQUENCY RANGE: 20 CPS TO 3 MC
SIMPLIFIED RANGE INDICATOR—SHOWS
ONLY RANGE IN USE

Accuracy: ± 3% full scale to 2 mc,
5% to 3 mc
Meter Ranges: .001 to 100, .003 to 300 (volts
full scale by factors of 10, calibrated rms
value of sine wave; 12 ranges)
db Ranges: —60 to +50, 10 db steps
Frequency Range: 20 cps to 3 mc
Input Imp.: 10 meg, 10 mmf
Dimensions: 7 1/4" W x 9 1/4" H x 8 3/4" D
Price: \$190.00

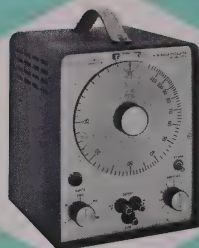
Note: Model 204 VTVM similar to above but
with 2 cps to 300 kc frequency range, \$175.00
Model 207A Log Scale VTVM, similar to Model
202A but with logarithmic scale for uniform
accuracy at any scale point, \$250.00



10 CPS TO 1 MEGACYCLE

± 1 DB OVER ENTIRE RANGE
HUM LEVEL LESS THAN 0.1%
DISTORTION LESS THAN 1.0%
DRIFT LESS THAN ± 2%
INTERNAL IMPEDANCE LESS THAN 55 OHMS

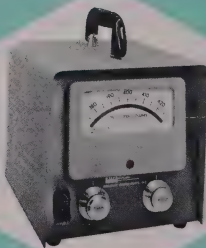
Frequency Range: 10 cps to 1 mc, 5 steps
Amplitude Variation: ± 1 db, 10 cps to 1 mc
Power Output: 160 mw/10 v open circuit/10 v—
600 ohm load
Dial Calibration: Better than ± 2%
Min. Load Imp.: 600 ohms
Hum Level: Less than 0.1% of rated output
Dimensions: 8" W x 9 3/4" H x 9" D
Price: \$140.00



ACCURACY OF ± 1/2 CYCLE

1 MA RECORDER CONNECTION PROVIDED
EXPANDED SCALE FOR EASY,
ERROR-FREE READING
ALSO AVAILABLE IN RACK MOUNTED FORM

Base Frequency: 400 cps*
Span: ± 25 cycles
Accuracy: ± 1/2 cycle
Price: \$330.00 (rack mounted form \$380.00)
*Also available in 60 cps Model



MEASURES RESISTANCE, CAPACITANCE,
INDUCTANCE, "Q" AND "D"
COMPLETELY SELF-CONTAINED
THE SIMPLIFIED PUSHBUTTON OPERATION
1 KC AND 10 KC INTERNAL OSCILLATOR
PROVISION FOR EXTERNAL GENERATOR
LINEAR SCALE DISTRIBUTION

Ranges: R—1 ohm to 10 megohm
L—10 μh to 100 h
C—10 μf to 100 μf
Q—0 to 6 (2 ranges)
D—0 to .12 (2 ranges)
Frequency Range: L & C at 1 kc or 10 kc;
R at dc
Accuracy: ± 5% (C, 10 to 100 μf, ± 3%)
Dimensions: 10 1/2" H x 16" W x 8 3/4" D
Price: \$495.00



PRICE LIST SHASTA INSTRUMENTS

MODEL	NOMENCLATURE	PRICE
201	AC-DC Voltohmeter	\$ 68.00
202A	AC - Vacuum Tube Voltmeter (20 cps to 3 mc)	190.00
204	AC - Vacuum Tube Voltmeter (2 cps to 300 kc)	175.00
207A	Log Scale AC - Vacuum Tube Voltmeter (20 cps to 3 mc)	250.00
301A	Wide Range Oscillator (10 cps to 1 mc)	140.00
601	High Resistance Bridge	150.00
604	Low Resistance Bridge	140.00
702A	Regulated Power Supply	205.00
854A	Wide Band Amplifier	135.00
854R	Wide Band Amplifier (Rack Mounted)	150.00
1201A	WWV Receiver	495.00
1210	Decade Inductor	275.00

Accessory Probes for the Model 201 Voltohmeter

950	Probe (crystal diode)	9.00
951	Probe (high voltage)	10.50
952	Probe (illuminated - ac dc)	10.50
953	Probe (ac - dc supplied with 201)	9.50
954	Test leads (red & black supplied with 201)	1.00

F. O. B. Richmond, Calif. - All Prices Subject to Change

Effective March 1, 1956

(over)



EXPANDED SCALE VOLTMETERS

	GENERAL PURPOSE	PRICE *
MODEL 101	Voltage Range 100-500 volts a.c. in 39 10-volt steps; Accuracy $\pm 0.25\%$ input voltage.....	\$360.00
MODEL 101-50	Voltage Range 50-250 volts a.c. in 39 5-volt steps; Accuracy $\pm 0.25\%$ input voltage.....	360.00
MODELS 101R, 101-R-50	Rack Mounting Model 101 or 101-50.....	400.00

PORTABLE SINGLE RANGE

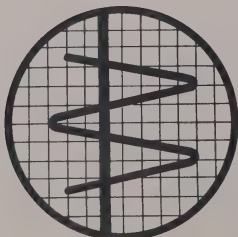
MODEL	VOLTAGE RANGE, A. C.	ACCURACY (Volts)	PRICE*
115A	110-120	± 0.5	\$105.00
115B	105-125	± 0.6	105.00
115C	100-130	± 0.7	105.00

EXPANDED SCALE FREQUENCY METERS

		PRICE*
MODEL 401	Indicating Frequency Meter for use with 0-1 milliampererecorder; Frequency Range 375 to 425 cycles per second; Accuracy of indicating meter ± 0.5 cycles.....	\$ 330.00
MODEL 601	Indicating Frequency Meter for use with 0-1 milliampererecorder; Frequency Range 55-65 cycles per second; Accuracy of indicating meter ± 0.25 cycles	330.00
MODELS 401R, 601R	Rack Mounting Model 401 or 601	380.00

EFFECTIVE MARCH 1, 1956

* FOB - RICHMOND, CALIF.



BECKMAN



FEATURES

- 10 OHM TO 100 MEGOHM RANGE
- SIMPLE PUSHBUTTON OPERATION
- HIGH ACCURACY
- NEGLECTIBLE DRIFT
- GUARD TERMINAL FOR HIGH-RESISTANCE MEASUREMENTS

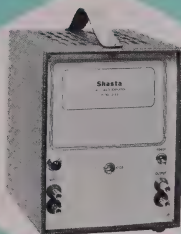
SPECIFICATIONS

- Ranges: 100, 1k, 10k and 100k ohms, 1, 10 and 100 megohms
- Lowest Meas.: 5 ohms
- Accuracy: $\pm$ (0.15% of res. meas., $\pm$.05% full scale)
- Drift: Negligible after 30 min. warmup
- Dimensions, weight: 9 $\frac{1}{4}$ "H x 8"W x 9"D; 8 lbs.
- Price: \$170.00



REGULATION $\frac{1}{4}$ % OR BETTER
RIPPLE LESS THAN 10 MV PEAK TO PEAK
0 TO 400 V OUTPUT @ 200 MA;
CONTINUOUSLY VARIABLE
0 TO -150 V BIAS OUTPUT @ 3 MA
INSULATED + AND - TERMINALS PERMITS
USE OF HIGH VOLTAGE WITH
REFERENCE TO GROUND

Output voltages: 0 to + 400 @ 200 ma
0 to -150 @ 3 ma
6.3 ac @ 8 amp.
Ripple, peak to peak: 10 mv or less
Regulation: Better than $\frac{1}{4}$ %, 0 to full load
Input: 105/130 v, 50-60 cycles
Dimensions: 8"W x 12"H x 10"D
Price: \$205.00



10 X AND 100 X VOLTAGE GAIN
 $\pm \frac{1}{2}$ DB RESPONSE 10 CPS TO 2 MC @
100 X GAIN, OR 5 CPS TO 2 MC @
10 X GAIN
LESS THAN 1% DISTORTION
1 MEG, 15 MMF INPUT IMPEDANCE
EQUIVALENT INPUT NOISE, 20 μ V @ 100 X
GAIN, OR 80 μ V 10 X GAIN
ALSO AVAILABLE IN RACK MOUNTED FORM

Input voltage req.: 100 mv rms max @
100 x gain
1 v rms max @
10 x gain
Output: 10 v max into min. of 3000 ohms,
resistive
Power requirements: 105/130 v, 50/60 cps,
67 watts
Dimensions: 9 $\frac{1}{4}$ "H x 7 $\frac{1}{4}$ "W x 8 $\frac{3}{4}$ "D
Price: \$135.00 [rack mounted form - \$150.00]



COVERAGE OF ALL WWV AND WWVH
FREQUENCIES
EACH FREQUENCY SELECTABLE BY
FRONT PANEL SWITCH
INDIVIDUAL CRYSTAL FOR EACH FREQUENCY
HIGH SENSITIVITY AND SELECTIVITY
COMPACT, RELIABLE CONSTRUCTION

Frequency Coverage: 2.5, 5, 10, 15, 20 and
25 mc
Sensitivity: Better than 1 μ v for 3 db signal
plus noise-to-noise
Selectivity: 1 kc at 3 db down
Dimensions: 19"W x 5 $\frac{1}{4}$ "H x 9-5/16"D;
relay rack mounting
Weight: 17 lbs.
Price: \$495.00



ACCURACY OF $\pm$ 1%
0.001 TO 11.11 HENRY RANGE IN
0.001 HENRY STEPS
LIGHT WEIGHT

Range: 0.001 to 11.11 henries,
0.001 henry steps
Accuracy: $\pm$ 1%
Max. Voltage: 1000 v dc
Dimensions: 12 $\frac{1}{2}$ "L x 4 $\frac{1}{8}$ "W x 4 $\frac{7}{8}$ "D
Weight: 8 $\frac{1}{2}$ lbs.
Price: \$275.00

**SHASTA quality instruments are sold and serviced by representatives
in 25 major cities throughout U.S. and Canada.**

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V. T. Rupp Company
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Albuquerque, New Mexico

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Baltimore 29, Maryland

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Cleveland 28, Ohio
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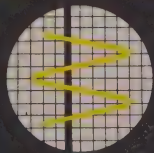
Dayton: 384 W. 1st St. Detroit: 2980 W. Davison Ave.
Hemlock 0662 TO 9-3141

SHORT FORM CATALOG

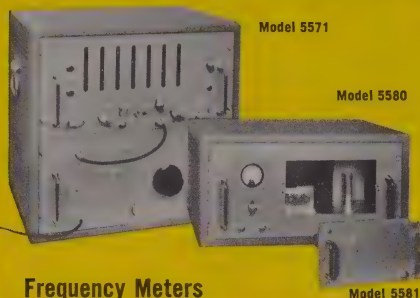
JULY 1955

Berkeley

division of Beckman Instruments Inc.
2200 Wright Ave., Richmond 3, California



Berkeley Precision Instrumentation



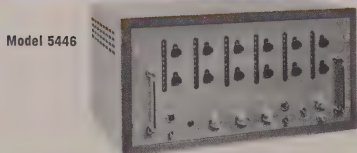
Frequency Meters



Universal Counters & Timers



Digital Recorders, Data Converters



Preset Counter Controllers



Double Pulse Generators

FEATURES

0-42 mc range without plug-ins, extendable to 515 mc with 5580 series converters. Direct-coupled input amplifiers. Direct connection to Model 1452 digital recorder, digital-to-analog converters, or 1440 series data converters described below. Coupling to WWV receiver or external frequency standard. Also serves as frequency ratio meter, 0-1 mc period meter, $1 \mu \text{ sec} - 10,000,000 \text{ sec}$ time interval meter, 0-2 mc EPUT, or 1 mc counter.

Model 5510 is a truly universal instrument providing the functions of a 0-1 mc frequency or frequency ratio meter, a secondary frequency standard, 1 mc counter, EPUT, and precision time interval meter. Operates directly into Model 1452 digital recorder or 1440 series data converters described below. (Individual counters, time interval or EPUT meters also available.)

Model 1452 Digital Recorder operates directly from Berkeley EPUT, time interval or frequency meters, scalars or counters. Records up to 8 digits on standard adding machine tape; can be modified to print "Time" or "Code" simultaneously with count data on same tape. Model 1440 series Data Reduction Converters take data from Berkeley meters, convert it for recording on IBM punches or electric typewriters.

Counts at rates to 40,000 cps, produces output signal at any desired preset total (or any two preset counts with dual preset models). Operates on input pulse of $\pm 1 \text{ volt peak}$, or more. Instantaneous reset to zero after final count. Reliable, simple to operate. Available in 2, 3, 4, 5 and 6-digit capacities.

Berkeley Double Pulse Generators produce paired or single pulses. Pulse amplitude, width, polarity, repetition rate and pulse-to-pulse spacing are independently adjustable. Outputs may be mixed internally or externally. Model 903 can be driven externally by pulses, Model 4904 by pulses or sine wave generators.

BERKELEY SYSTEMS ENGINEERING

Berkeley Systems Engineering is described by our new brochure C-901. Such applications as data reduction, telemetering, analog control of process, tachometry systems; measurement, recording, and control of pressure, temperature, and flow are discussed.

We feel that many of the advantages of limited automation—that is, partial loops—are neglected owing to a rather profuse fund of misinformation on what is both technically and economically feasible. Our brochure should give you an indication of what can be done today for X number of dollars invested in the way of saving time, money, and effort.

Any member of our systems engineering staff will be happy to discuss your specific problem with you. He will point out the part Berkeley can play by offering complete single source, single responsibility systems design, manufacture, and installation.

for Laboratory and Production Line

SPECIFICATIONS, PRICES

APPLICATIONS

Frequency Meas. Range: 0 cycles to 42 mc, extendable to 515 mc
 Time Interval Meas. Range: 1 μ sec to 10⁷ seconds
 Period Meas. Range: 0 to 1 mc (Period x 10, 0 to 100 kc)
 Input Requirements: 0.1 v rms
 Time Bases: Frequency: 0.000002 to 20 seconds. Time interval and Period Meas: 1 mc to 1 cps (decade steps)
 Accuracy: ± 1 count, $\pm$ crystal stability
 Crystal Stability: Temperature stabilized to 1 part in 10⁷ (short term)
 Display Time: 0.2 to 5 seconds
 Power Requirements: 117 v $\pm$ 10%, 50-60 cycles, 260 watts
 Dimensions: 20 $\frac{3}{4}$ " W x 19" H x 16" D. Weight, 100 lbs. (Rack mtg. avail.)
 Model 5571, \$1,650; Model 5580 converter, \$300;
 Model 5581 plug-ins, \$100 - \$150 each

Input Sensitivity: 0.2 v rms (Freq. meas.); 1.0 v peak to peak (other functions)
 Input Impedance: 10 megohms shunted by 35 mmf
 Time Bases: 1 mc; 100, 10, and 1 kc; 100, 10, and 1 cps
 Gate Times: .00001, .0001, .001, .01, 0.1, 1.0 and 10 seconds
 Crystal Stability: 1 part in 10⁶ (temp. controlled)
 Display Time: 0.2 to 5 seconds
 Accuracy: ± 1 count, $\pm$ crystal stability
 Power Requirements: 117 v ($\pm$ 10%) 50-60 cycles, 400 watts
 Dimensions: 20 $\frac{3}{4}$ " W x 10 $\frac{1}{2}$ " H x 15" D
 Price: Model 5510, \$1,100

MODEL 1452

1440 SERIES

Capacity:	6 digits (8 on order)	up to 6 digits
Input:	— Direct from Berkeley decades —	
Output:	Adding machine tape	IBM punches, elec. typewriters
Max. Cyc. Rate:	0.85 sec for 6 digits	Speed of punch or typewriter
Dimensions:	19" W x 10 $\frac{1}{2}$ " H x 14" D	20 $\frac{3}{4}$ " W x 10 $\frac{1}{2}$ " H x 15" D
Weight:	60 lbs.	40 lbs.
Price:	\$750 (6 digit)	\$980 to \$1,365

Input Frequency: From dc to 40,000 cps
 Input Sensitivity: ± 1 v peak referred to ground (minimum)
 Output Signal: (1) 45 v pulse (-35 to $+10$ v), duration adj. 12-150 μ sec
 (2) Pulse-relay: Form C contacts (250 va rating); duration adj. 0.02-0.4 sec
 Dimensions: 20 $\frac{3}{4}$ " W x 10 $\frac{1}{2}$ " H x 15" D
 Price, Single Preset: \$435 (2-digit Model 5422) to \$740 (6-digit)
 Price, Dual Preset: \$560 (2-digit Model 5442) to \$840 (6-digit)

MODEL 903

MODEL 4904

Pulse Width:	0.15 to 1.8 μ sec	0.3 to 10 μ sec
Max. Amplitude:		
1000 ohm load:	-200 v, $+50$ v	-160 v, $+75$ v
50 ohm load:	-10 v, $+2.5$ v	-5 v, $+2$ v
Rise Time:	0.035 μ sec	0.08 μ sec
Decay Time:	0.15 μ sec	0.26 μ sec
Pulse Spacing:	0 to 10 μ sec	0 to 100 μ sec
Freq. Range:	1 to 1000 cps	1 to 10,000 cps
Dimensions:	14 $\frac{1}{2}$ " W x 9 $\frac{3}{4}$ " H x 10 $\frac{1}{2}$ " D	20 $\frac{3}{4}$ " W x 10 $\frac{1}{2}$ " H x 15" D
Weight:	35 lbs.	68 lbs.
Price:	\$440	\$540

Measurement of unknown frequencies, frequency ratios, periods. Counting, time interval, EPUT measurements. Filter and crystal testing, oscillator calibration and testing, design and testing of telemetering, transmitter and receiver equipment, transmitter monitoring, precision phase measurements, etc.

Precision tachometry, measurement of pressure, flow, frequency, velocity, viscosity, elasticity, time interval measurement, timing relay, shutter action, precision phase measurements, etc.

Permanent recording of data without manual transcription; automatic recording of data on IBM punch cards, or in typewritten form. Transcribes any data in digital form that can be measured by Berkeley decades.

Control of counting, weighing, sorting, packaging, shearing, metal forming, coil winding equipment; cut-off of motors, turbines, jet engines at precise predetermined rev count or speed, computer timing, etc.

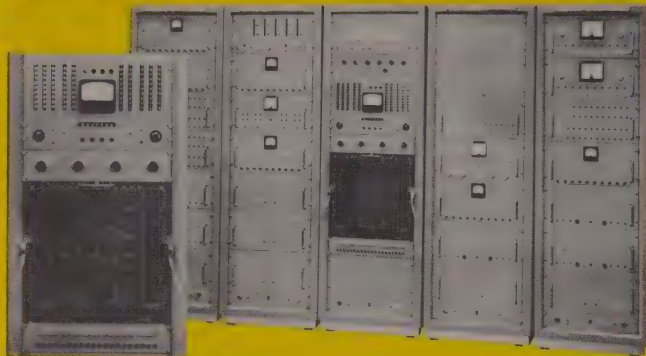
Measurement of rise or decay time, transient response of pulse forming circuits, electronic switches, gates, wide band amplifiers; paired pulse resolution time; pulse amplifier overload characteristics and dynamic range, delayed coincidence work, etc.

BERKELEY NUCLEAR INSTRUMENTATION

A complete line of nuclear instrumentation, designed to the most rigid requirements of industry, research, and medicine, is described by separate catalogs. Catalog C-202 describes our standard nuclear instruments and accessories such as scalars, rate meters, scintillation counters, G-M tubes, lead shields, and monitoring instruments. In addition, Berkeley supplies recording systems, data converters, automatic sample changers, and supervisory elements for automatic sample counting and process control. Catalog C-201 delineates radioisotope equipment for medical use including the I-31 Uptake Analysis System for chyroid diagnosis. A technical bulletin describes nuclear instruments for tracer research.

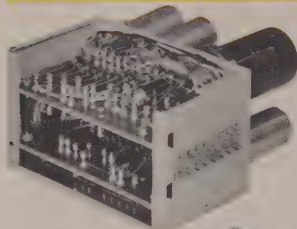
DETAILED INFORMATION AVAILABLE ON REQUEST

New EASE* Computers and Components



New High-Accuracy Patch Bay and Pushbutton Control

Model 1032 Receptacle-Control features centralized pushbutton control of problem solution, coefficient setting, monitoring. Master or slave control, repetitive or non-repetitive. 0.1% rc components for high accuracy. Large capacity—handles 50 amplifiers, 16 multipliers, 5 diode function generators, 102 pots, 10 diodes; has 126 blank contacts for other equipment, 40 interconnections for second computer. Rapid set-up patchboard with positive-contact lock device. Rack or console mounting. Early delivery, reasonable cost.



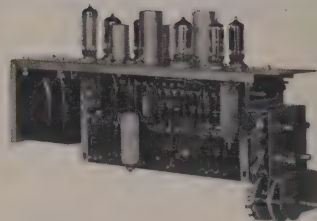
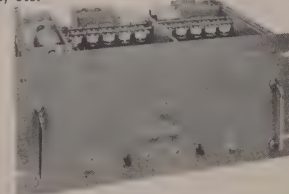
New High Precision DC Amplifier

Model 1048 D.C. Amplifier is high precision compact plug-in type featuring chopper stabilization for low drift (less than 100 μ volts referred to summing junction), greater than 1×10^6 gain, less than 0.01 ohm output impedance, excellent frequency response, high power output with large voltage range. Ideal for recorder or scope pre-amp, servo systems, general laboratory use, etc.



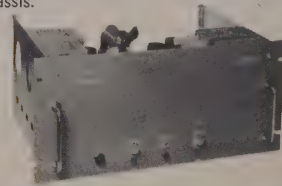
New Automatic Set-Up Function Generators

Model 1072 Function Generator Control, used with Model 1071 Function Generators, provides the greatest convenience and time saving yet offered in function generator set-up. A 20-line segment approximation of arbitrary functions can be obtained by merely inserting the coordinates of the 20 points on the digital pushbutton keyboard. A servo potentiometer setting system does the rest. Rapid check of function inserted is obtained from oscilloscope on Model 1072 panel. Frequency response of the Model 1071 is generally flat, ± 1 db to 1000 cps. One Model 1072 handles up to 10 Model 1071 function generators.



New, Versatile Electronic Function Multipliers

Model 1056 Function Multipliers offer four quadrant operation (product $-.01xy$). Probable error less than 0.5 v over ± 100 v product range; monotonic, decreasing to zero for small products. Drift less than 0.2 v over normal computing range. High frequency response, less than 2.5° phase shift at 100 cps. Very compact; four Model 1056 units fit into standard 8 1/4" x 19" chassis.



New Precision Reference Voltage Supply

Model 1015 Computer Reference Voltage Supply provides an output of ± 100 v at 100 ma each. Offers precise tracking; ± 100 v output tracks -100 v output within ± 2 mv. Either output varies less than 1 mv for zero to full load change, and less than 10 mv for 10 v line change. Excellent stability; outputs are constant to 10 mv. Offers convenient slaving with Model 1016 Slave Supply to give total current capacity of ± 1 amp.

It Pays to make BERKELEY your Headquarters for Analog Computing, Simulation and Control Equipment

Availability of standard, matched EASE* components permits prompt delivery of complete computer, simulation or control systems to meet your specific requirements. There's no lost time, no premium in cost for the proved superiority of EASE* performance, convenience and accuracy. For example, a complete EASE* computer with 30 amplifiers, 4 function generators, 4 function multipliers, 60 servo-set pots and complete receptacle-control unit costs only \$14,000.00 with Model 1031 receptacle-control, or \$19,800.00 with the 0.1% rc-component Model 1032.

For complete data, call your nearest Berkeley representative (list below) or write Dep't N13, Berkeley division, Beckman Instruments, Inc., 2200 Wright Ave., Richmond 3, California.

SAN FRANCISCO, G. E. Moxon Sales
SARATOGA SPRINGS, Edward A. Ossmann & Assoc., Inc.
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DETROIT, J. R. Dannemiller Assoc.
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HOUSTON, John A. Green Company

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NEW INFORMATION ON ELECTRONIC

MEASUREMENT, CONTROL and COMPONENTS

DATE: August 26, 1957

NATIONAL ISA SHOW TO BE HELD IN CLEVELAND SEPT. 9-13

All of our Principals will be represented:

Beckman/Berkeley — 1132 Computer	Booth 1440
Beckman/Systems — Data Handling Equipment	Booth 1440
Offner — Direct-Writing Rectilinear Oscillograph Recorders	Booth 212
Southwestern Industrial Electronics — Vacuum Tube Voltmeter, R C Oscillators	Booth 1474
J. R. DANNEMILLER ASSOCIATES	Booth 308
Ballantine — Vacuum Tube Voltmeters Capacitance Meter	
Du Mont — 400 Series Oscilloscopes	
Dressen-Barnes — DC Power Supplies	
Berkeley — 10 MC, Portable and Preset Time Base Counters	

Invitations for the Show are herewith enclosed.

J. R. Dannemiller is conducting a class on Electronic Counters as part of the ISA Maintenance Clinic Sept. 7-8 at Fenn College in Cleveland.

MIDWEST SIMULATION COUNCIL MEETING SEPTEMBER 11, 1957 AT PUBLIC AUDITORIUM

The next meeting is being held concurrently with the ISA Show in Cleveland. This meeting is being sponsored by Sohio and Beckman/Berkeley — any interested party may attend. Contact our Cleveland office for details.

BECKMAN/BERKELEY ANNOUNCES NEW INSTRUMENTS

MODEL 7700 FREQUENCY COUNTER MONITORS TRANSMITTED SIGNALS. Frequency measurements are performed by connecting a Collins 51J4 communication receiver to a standard Berkeley counter through a processing or translator unit. The counter will then accurately indicate any carrier frequency presented to the receiver within .54-30.4 MC.

READ RPM OR FLOW DIRECTLY. Models 7351 and 7361 Presettable Time Base Universal Eput Meter for direct digital readout without conversion.

10 MEGACYCLE COUNTER to be shown at ISA Show September 9th — Models 7370, 7270, 7170. Mailing will reach you soon.

TWO MEGACYCLE EXTENSIONS AVAILABLE for 7160, 7360 (new instruments only). Modification "J" can be specified to extend range, on B channel only for Universal Counter.
Total Price including Modification: EPUT \$1125.00
UNIVERSAL \$1325.00

TIME INTERVAL MEASUREMENTS AND HOW TO MAKE THEM

Data File 112 just released by Beckman/Berkeley; return attached Business Reply Card for your copy.

SEVERAL SHASTA MODELS NOW PRODUCED BY BERKELEY

The Shasta Division of Beckman has been absorbed by the Berkeley Division. The following instruments will be put into production by the Berkeley Division:

- 404 Expanded Scale Frequency Meter, Range 375-425 cycles, accuracy $\pm 1/2$ cycle.
- 101 Expanded Scale Voltmeter, Range 100-500V, or 50-250V, accuracy 0.25%.
- 100 Synchro Tester (Transformation Ratio Meter) Input 57.3 - 115V, accuracy $\pm 0.2\%$
- 605 Wide Range Resistance Bridge, 10 ohms to 100 meg-ohms, accuracy $\pm 0.2\%$ to $\pm 0.65\%$ of value.

Detailed literature available upon request.

J. R. DANNEMILLER ASSOCIATES SERVICE FACILITIES

All three of the J. R. Dannemiller Associates offices have facilities and qualified personnel to repair all of the instruments we sell.

BALLANTINE DELIVERY IMPROVED

The Models 300 Electronic Voltmeter, 520 Capacitance Meter, 700 Sensitive Inverter and 220V Decade Amplifier are now stock items from Ballantine.

DU MONT WIDE BAND DIFFERENTIAL AMPLIFIER

The Model 342 was designed to improve your present Scope.

Maximum Gain 20X
Rise Time Less than .024 μ seconds
Common-mode signal rejection better than 1000:1 in midband
PRICE — \$358.00
Delivery — 1 week

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**LITERATURE — AVAILABLE ON ALL THE ABOVE BY
FILLING OUT THE ENCLOSED BUSINESS REPLY CARD**

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BERKELEY DIVISION

ALLEN B. DU MONT LABORATORIES
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**POLAROID POSITIVE TRANSPARENCY FILM NOW AVAILABLE
FOR USE WITH DUMONT 302 CAMERA**

Film, necessary "dipit" developing solution or field kit containing one roll of film, "dipit" and eight slide mounts in carrying case are on sale either from Du Mont or your Polaroid Dealer. We recommend the field kit as a starter. Detailed literature is available on 302 camera.

MODEL 404 PULSE GENERATOR SYNC INPUT IMPROVEMENT

When the type 404 is triggered from an external source, jitter may be further reduced between the source and the trigger output signal. Circuit improvements have been made to minimize this jitter. If you need the changes, return the reply card.

THE FOLLOWING DU MONT DEMONSTRATORS ARE BEING OFFERED AT A REDUCED PRICE. ORDER SHOULD BE MADE OUT TO J. R. DANNEMILLER ASSOCIATES AT OUR CLEVELAND ADDRESS.

Model	Screen	Item	Normal List Price	Sale Price
302	F1.9 Lens	Oscilloscope Record Camera	\$391.00	\$332.35
346		Amplifier Voltmeter	220.00	187.00
348		Oscillator	358.00	304.30
350	P1	Oscilloscope	435.00	326.25
350	P7	Oscilloscope	435.00	326.25
401	P1	Oscilloscope	462.00	392.70
329-A	P1	Oscilloscope	1200.00	850.00
329-A	P2	Oscilloscope	1200.00	850.00
901		Engine Scope	725.00	598.13
901 Attachments:				
2901		Noise & Vibration Pickup	67.50	55.68
2902		Flame Pickup	27.50	22.68
2905		Accessory Cable	5.00	4.13

SIE'S BIG PACKAGE FOR \$200

The C-6 Resistance Meter made by Southwestern Industrial Electronics should not be overlooked in the resistance measurements field.

RANGES:

Ohm: 0-500,000 Ohm, 1-1/2 V Potential
Megohm: 100,000 Ohm to 1,000,000 megohm in 6 steps,
50V Potential
1 Megohm to 10 million megohms in six steps,
500V Potential

ACCURACY:

Ohm Range: 3% of full scale deflection ± 1 ohm.
Megohm Range: 3% of full scale deflection on the first 5 ranges, 5% on last range.

WEIGHT — 10 lbs.

Price — \$200.00

HUMOR — WE HOPE

The engineer's two sons were complete opposites, one being an optimist, the other a pessimist. Dad decided to test the boys' reaction to the most extreme adverse conditions in order to moderate these personalities. The pessimistic boy was locked in a room full of toys for a day, the optimistic one in a room full of horse manure. When Dad unlocked the doors to see what effect had taken place, he found the pessimistic lad muttering amidst the toys "Someone will take these away from me", and the optimistic boy was discovered digging his way into the pile of horse manure saying "there must be a pony here someplace".

We hear that Du Mont has competition in the low frequency oscilloscope field, thought you would like to compare.

Make	Price	Deflection Factor	Band Pass	Identical X & Y Amp.	Sweep Calibration		Suggested Use	Driven Sweep	Guarantee	Price For Rack Mounting
					Range	Steps				
Du Mont 304-A	\$413.00	25 P-P MV/Inch	10% Down 100 KC 50% Down 300 KC	No	None		Lab & Production	Yes	1 Yr.	\$495.00
Du Mont 350	\$435.00	25 P-P MV/Inch	30% Down 150 KC	Yes	None		Lab & Production	Yes	1 Yr.	\$478.00
Du Mont 401	\$462.00	25 MV/ Inch	30% Down 150 KC	Yes	125M Sec/Inch to 10 μ Sec/ Inch	18	Lab & Production	Yes	5 Yrs. On P.W. Board & Transformers	\$495.00
Du Mont 403	\$580.00	1 MV Full Scale (4 Inches)	DC To 300 KC	No	500M Sec/ CM To .5 μ Sec/ CM	19	Lab & Strain gage	Yes	5 Yrs. On P.W. Board & Transformers	\$595.00
Manufacturer A	\$650.00	1MV/ CM	DC To 300 K	Similar	5 Sec/CM To 1 μ Sec/CM	21	Not Sure	Yes	1 Yr.	Not Available
Manufacturer B	\$825.00	50 MV/ CM	DC To 5 MC	No	12 Sec/CM To .2 μ Sec/CM	21	Not Sure	Yes	1 Yr.	On Request

ACCURACY $\pm 0.25\%$!

Shasta Expanded Scale Voltmeters

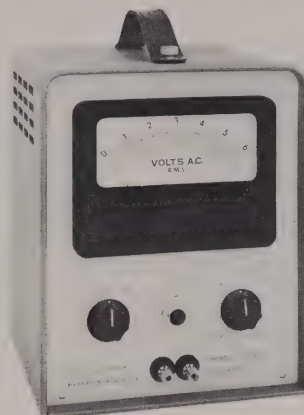
MODELS 101 AND 101-50

FEATURES: ★ Accuracy of $\pm 0.25\%$

★ True rms Reading

★ 0-1 ma Recorder Connection

★ Rugged design to withstand vibration, rough usage



Portable Models 101 (100-500 v)
and 101-50 (50-250 v)

DESCRIPTION:

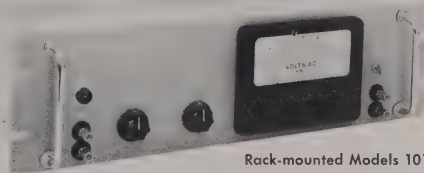
Available as either portable or rack-mounted units, these rugged instruments provide true rms readings at an accuracy of $\pm 0.25\%$ of input voltage over a range of 100-500 v in 10 v steps (Model 101), or 50-250 v in 5 v steps (Model 101-50). Large scale divisions reduce reading errors; results may be permanently recorded on a 0-1 ma recorder. Use of a unique thermal bridge circuit provides $\pm 0.25\%$ accuracy with standard meter movement, eliminating delicate special movements. The result is unusual ruggedness for an instrument of such high accuracy.

APPLICATIONS:

Shasta Expanded Scale Voltmeters are invaluable for all types of testing and development work where high accuracy is a requisite; production quality control of components and circuits, developing new circuits, servicing electronic instruments and systems, measuring voltages in a-c power systems, as a reference instrument in the standards laboratory, and for measurements of line voltage variations in the field. They are adaptable for use in aircraft where vibration might damage more delicate meter movements.

SPECIFICATIONS

	MODEL 101	MODEL 101-50
RANGE:	100 v to 500 v	50 v to 250 v
SCALE RANGE:	12 v	6 v
SMALLEST SCALE DIVISION:	0.2 v	0.1 v
ACCURACY:	$\pm 0.25\%$ of Input Voltage	
VOLTAGE INDICATED:	True rms	
FREQUENCY RESPONSE:	50 to 2000 cps	
SOURCE LOADING:	Approximately 2 watts	
METER DAMPING:	0.8 of Critical Damping	
TIME RESPONSE:	0.5 seconds	
RECORDER CONNECTIONS:	0-1 ma dc recorder	
POWER REQUIREMENTS:	115 v ac, 50-2000 cps, 20 watts	
DIMENSIONS: (PORTABLE)	8"W x 9 3/4"H x 9"D (14 lbs. net)	
DIMENSIONS: (RACK)	19"W x 5 1/4"H x 9"D (15 lbs. net)	
PRICE: (PORTABLE)	\$360.00 f.o.b. factory	
PRICE: (RACK)	\$400.00 f.o.b. factory	



Rack-mounted Models 101-R and 101-R-50

Complete technical data is yours for the asking; why not write us now? Please address Dept. _____

Beckman

Shasta Division

P. O. Box 296, Station A
Richmond, California

Telephone LAndscape 6-7730

Arnold O. Beckman INC.

**SELF-
READING**

POCKET DOSIMETERS

More and more organizations are finding themselves engaged in the study and application of radioactive materials. You are keenly aware of the dangers involved with these materials and of the necessity for monitoring the exposure during their handling. Wherever human welfare is involved, you naturally desire the best equipment available to insure maximum safety.

SELF-READING QUARTZ FIBER DOSIMETER EMERGES AS BEST

Many devices for monitoring the exposure from radioactive materials have appeared on the market over the past years. The instrument which through actual use emerged above all others in regards to safety, accuracy, and convenience, is the self-reading quartz fiber dosimeter. It was selected as superior over other devices by the military and civilian defense agencies.

OUTSTANDING FEATURES

The self-reading quartz fiber dosimeter is superior because . . .

- ... it is read instantly — no delay for processing or developing!
- ... its fiber indicator is read directly — no accessory is required!
- ... its cumulative measurement is not destroyed by supplementary reading apparatus or chemical processes!
- ... it is the most accurate of dosimeters — is extremely compact, light in weight, and convenient to use!
- ... its shelf life is indefinite — no deterioration or loss of usefulness due to age!

THE FINEST DOSIMETER AVAILABLE

Arnold O. Beckman, Inc. was the first to introduce compact, hermetically sealed dosimeters of unequalled optical efficiency. They not only provide the best in readability, but also the greatest independence from radiation energy level. Arnold O. Beckman Dosimeters consist of an energy independent ionization chamber, a quartz fiber electrometer, a microscope with a reticle scale for viewing the position of the fiber, and a special switch for charging the electrometer — all assembled and hermetically sealed. The electrometer is initially charged to approximately 170 volts and, when exposed to gamma or X-ray radiation, is discharged in direct proportion to the total accumulated exposure since charging. Efficient production methods and high quality workmanship have established Arnold O. Beckman, Inc. as leading manufacturers in the field of self-reading quartz fiber dosimeters.



Actual Size of Dosimeter
(Models 102 and 104)

RANGES AVAILABLE:

Model 102	0-200 Mr
Model 104	0-1 R
Model 105	0-5 R
Model 110	0-10 R
Model 150	0-50 R
Model 160	0-100 R
Model 170	0-200 R

GREATER ECONOMY!

One of the most outstanding features of Arnold O. Beckman Dosimeters is their economy. The investment made not only in the instrument itself, but in the safety and reliable service it provides, costs less than 1¢ per reading when amortized over normal service life.

- Price, each, Model 102 35.00
- Price, each, Models 104, 105, 110, 150, 160, 170 43.50
- Price, each, Model 103A Charger 47.50

Note: Quantity discounts offered
Prices Effective 8-15-54

*mail
this
Card
Today*

TO:

Arnold O. Beckman INC.

Please send me literature containing additional information regarding your self-reading quartz fiber dosimeters. I am interested in the following range(s):

- ☐ 0-200 Mr ☐ 0-1 R ☐ 0-5 R ☐ 0-10 R ☐ 0-50 R ☐ 0-100 R ☐ 0-200 R

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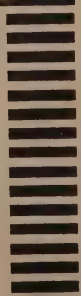
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Arnold O. Beckman INC.

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SOUTH PASADENA, CALIFORNIA

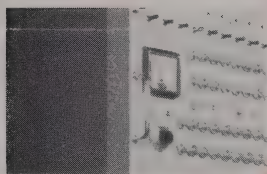


the **EASE*** 1100 series

with

Digital **O**utput
Input **T**ranslators

series



a new adventure in electronic computing

Berkeley division of Beckman Instruments Inc.

Beckman /
Berkeley

shortcut to



DO/IT (Digital Output-Input Translator system) is a major feature of the new EASE* 1132 for automatic operation and high accuracy.

accomplishment

DO/IT WITH **EASE***

Berkeley's new EASE* 1132 represents a wholly-new concept in analog computation — a complete **system** for solving computation and simulation problems **automatically**, with a minimum of human attention and possibility for human error.

Features of the EASE* 1132 that provide improved operational convenience, speed and accuracy include:

1. Digital input-output by means of punched tape or electric typewriter.
2. Automatic static or dynamic problem checking.
3. Complete pushbutton monitoring system.
4. Fully shielded, color-coded patch board.

The advanced-design EASE* 1132 offers today's greatest opportunity for better utilization of scientific-engineering brainpower, faster research and development progress. Why not investigate **now**? A letter will bring details promptly; please address Dept. _____.



Beckman®

Berkeley Division

Richmond 3, California

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Nation-wide Sales & Service

Berkeley EASE* computers are sold and serviced by authorized Berkeley representative organizations conveniently located in or near the major cities listed below. They are well qualified to discuss your computer problems, and to provide factory-trained technicians for computer maintenance and service.

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Beckman*

Berkeley Division
Richmond 3, California
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SERVOMULTIPLIER PERFORMANCE

by MARK HARRIS

The electronic analog computer is a powerful aid in the solution of problems not amenable to analytic solution — particularly those involving non-linearities. A modern analog computer must simulate equations having non-linearities, generate non-linear functions, and perform non-linear operations. In the latter category we have the operation of multiplication. A number of devices have been developed for performing this operation,¹ and in this article we will discuss the characteristics of one of these devices, the servomultiplier. We will

consider those characteristics which influence accuracy and speed of response and indicate those factors which enable us to measure and define system behavior.

This article is divided into two parts. The first section contains a brief description of the operational aspects of the servomultiplier and a comparison with an electronic multiplier. The second section concerns specification of performance, the information required for the evaluation of performance, and the present lack of uniform terminology relating

to accuracy and speed of response.

Despite significant advances in the performance of electronic-multipliers,

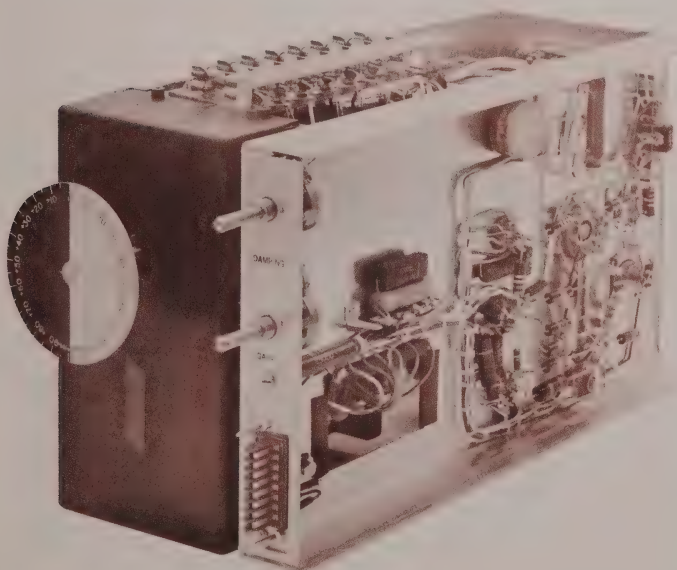
EDITOR'S NOTE

**"The time has come, the walrus said,
To talk of many things."**

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ROBERT SCHWEITZER



Berkeley, Model 1191 Servomultiplier. This unit contains five computing potentiometers mounted on a shaft behind the shaft-position indicator. Two such units fit into a single 19-inch chassis.

most modern electronic analog computers continue to utilize a large number of servomultipliers in problem solution. The simplicity, reliability, and ease of adjustment of the servomultiplier are factors which contribute to its continuing popularity. Its versatility in being able to perform a number of varied operations and its economy in both size and cost in obtaining a large number of product pairs (i.e. products having a common multiplier) considerably outweigh its comparatively low speed of response.

While commercial servomultipliers may differ considerably in their design details, they all utilize the same basic system for their operation. The input signal is used to position a shaft on which the output elements are located. For most computer applications the output elements are precision potentiometers and the system operates as shown in Figure 1. The voltage appearing at the wiper of each potentiometer will be a function of both the voltage applied across its coil and the position of the shaft to which the wiper is attached. If the potentiometers are wound so that the resistance varies linearly with rotation, then the wiper voltage will be proportional to the product of the applied voltage and the shaft position. One of the potentiometers (called the "follow-up" or "feedback" pot) is connected to stable reference voltages and the output of this potentiometer is compared to the input signal. The amplified error voltage is used to drive a two-phase servo motor which rotates the

shaft of the potentiometers until the output of the "follow-up" potentiometer is equal to the input voltage. When the null is reached, the output at the wiper of each potentiometer is proportional to the voltage applied to its coil multiplied by the input voltage.

Servomultipliers are generally supplied with six, ganged potentiometers: five for computing operations and one follow-up pot. When all the potentiometers are linear, five variables may be multiplied by a sixth. The versatility of the servomultiplier arises from our ability to utilize different types of potentiometers. Non-linear and multi-tapped potentiometers make possible operations such as function generation, interpolation, coordinate transformations, etc. Multi-turn potentiometers can be used to increase the accuracy, or can be combined with single-turn potentiometers for the generation and resolution of sines and cosines of angles greater than 360° .

The servomultiplier, being an electromechanical device, is incapable of rates of response comparable with completely electronic equipment. When the servomultiplier is used in conjunction with other analog computer elements, the useful frequency range of the computer will be determined by the response of the servomultiplier. If this restricted frequency range cannot be tolerated, (which will be the case when a high rate of solution is necessary) the servomultiplier must be replaced by an electronic equivalent. With few exceptions each of the operations performed by the

servomultiplier can be duplicated by electronic equipment.

In instances where the frequency response does not dictate the choice between the servomultiplier and the electronic element, selection is made on the basis of economy, ease of adjustment, reliability, etc. A comparison between the servomultiplier and the electronic multiplier will be used to exemplify these points.

In obtaining the product of two variables ($X \cdot Y$) the electronic multiplier is the more economical device. If a number of products having a common multiplier factor are required ($X \cdot Y$, $X \cdot Z$, $X \cdot W$), the servomultiplier is more advantageous. On the basis of number of output channels per unit cost the servomultiplier is approximately three times as economical.

As stated above the servomultiplier does not approach the electronic multiplier in frequency response. An electronic multiplier will operate satisfactorily in the neighborhood of 100 cps. (The EASE Model 1056B, for example, has less than 2.5° phase shift to 100 cps. and is flat within ± 2 db. to 1000 cps.) Furthermore, the response of the electronic multiplier is independent of signal amplitude. The response of a servomultiplier is adversely affected by signal amplitude. Most servomultipliers develop significant errors at about 10 cps when the signal amplitude is 10% of maximum (or, twenty volts peak-to-peak) and at correspondingly lower frequencies as the signal amplitude is increased.

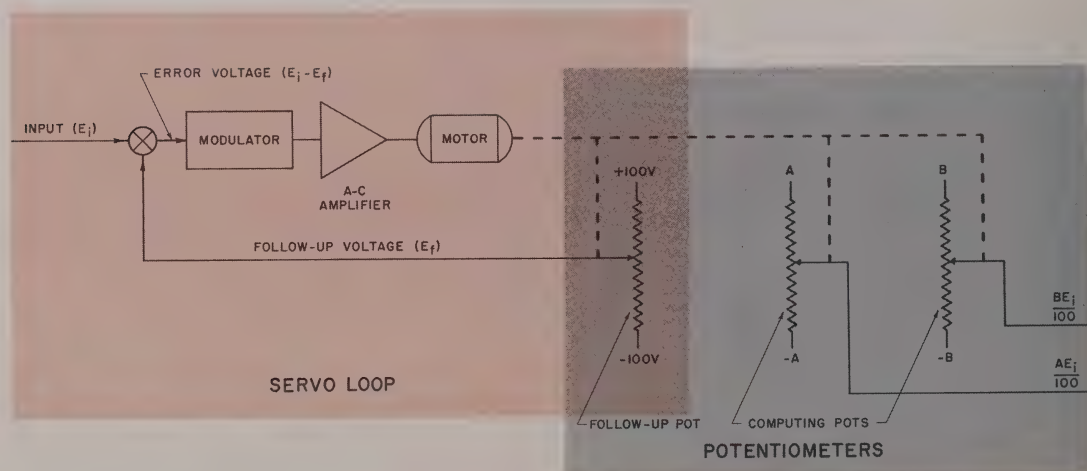


Figure 1. Diagram of a servomultiplier showing two computing potentiometers. The mechanical linkage between pots is represented by a dotted line. Ordinarily, all three pots would be mounted on a single shaft which the motor drives through reduction gears. "A" and "B" are voltages varying with time. "-A" and "-B" have the same magnitude as A and B but opposite polarity.

When operated within their respective frequency limitations the electronic multiplier and the servomultiplier have approximately the same short-term accuracy. Due to drift and other factors the electronic multiplier must be rebalanced at frequent intervals (usually, once a day) if the accuracy is to be maintained. Servomultipliers are inherently drift-free and no adjustments of this nature are required. Servomultipliers are generally provided with gain and damping adjustments for optimizing performance, but these adjustments, once made, rarely require attention.

Recent improvements in the design of electronic multipliers have resulted not only in greater accuracy but also in a marked increase in reliability. The servomultiplier, however, continues to enjoy the reputation of being more reliable of the two. The electronic multiplier, having a larger tube complement and more complicated circuitry, is more prone to trouble due to component failure. Being an open-loop device it exhibits a greater dependence on circuit and tube parameters and is more apt to fail without warning or advance indication than the servomultiplier.

The most frequent cause of failure in the servomultiplier arises from damaged or worn potentiometers. As the potentiometers wear they become noisy and must be replaced eventually. Occasionally, on tapped potentiometers, winding failures are produced by accidental over-voltages; or, subjected to extreme shock or vibration, the lead wire from the coil to the tap may break, but such occurrences are rare. A precision, wirewound, potentiometer is extremely reliable and rugged, and a usable life of several million cycles is quite normal. For these reasons the servomultiplier has a lower incidence of failure or erratic behavior due to faulty or malfunctioning components, but this advantage is partially offset by the necessity for a major overhaul when the potentiometers reach the end of their useful life.

The constant improvement of the higher speed electronic elements pre-sages their eventual assumption of most functions now performed by the servomultiplier. In the following pages it will be seen that the servomultiplier is best suited to high-accuracy applications, and in these applications it will continue to fulfill an important role in analog computers.

SPECIFYING AND EVALUATING

While the specification and evaluation of performance should be a relatively simple technical problem, the lack of consistent terminology and adequate standards may produce severe semantic

difficulties. It is not difficult to list the causes of error and the effects which are detrimental to system accuracy, but when we turn to the quantitative aspects of system performance we must come to an agreement regarding how we will measure and evaluate these effects. The manufacturer must be able to describe the operational characteristics of his equipment clearly and unequivocally, and the customer must be able to specify his requirements without ambiguity.

It is regrettable that there are nearly as many methods of specifying servomultiplier performance as there are manufacturers of servo equipment. This lack of uniformity results in a profusion of terms, such as static error, dynamic error, dynamic null error, servo error, servo nulling error, tracking error, dynamic tracking error, etc. While the meaning of some of the above terms appears to be self-explanatory, their use without adequate definition can cause confusion.² In the discussion below some of the above terms have been defined and used and wherever possible an "acceptable" or "standard" definition is given.³⁻⁴ However, it must be cautioned that the meaning ascribed to these same terms in other literature may not be the same.

In literature describing analog computer components the practice of using the word "accuracy" as a synonym for the word "error" has become so firmly ingrained that it would not appear to be a source of confusion. Thus a device having an output error of less than, say, 0.1%, is said to be accurate within 0.1%; or, more generally, to have an accuracy of 0.1%. Before proceeding to a discussion of servomultiplier errors and their specification, let us define the term "error" and percentage error as applied to the servomultiplier output. The term "output error" will mean "ideal output minus actual output." When the end terminals of the follow-up potentiometer are connected to +100 volts and -100 volts, the total range is 200 volts and:

$$\text{Percent Error} = \frac{\text{Error (in volts)}}{200} \times (100)$$

The output error may be divided into two parts; namely, potentiometer errors and servo loop errors. Potentiometer errors will be those inaccuracies which would be present with real potentiometers and an ideal (error-free) servo loop. The servo loop error will be the error remaining after accounting for all potentiometer errors, or, more explicitly, the input voltage (E_i) minus the voltage at the follow-up potentiometer (E_r). The total possible output error will then

equal potentiometer error plus loop error.

Potentiometer Errors

With an ideal servo loop the output error of a servomultiplier will depend entirely on the conformity between the computing potentiometer and the follow-up potentiometer. We must specify the allowable variation in order that the output error may remain within acceptable limits. The accuracy of a potentiometer is generally stated by specifying its linearity tolerance.⁵ A perfectly linear potentiometer would have a straight line relationship between the voltage measured at the sliding contact and the rotation of the shaft. The linearity tolerance (more briefly, linearity) is the maximum allowable deviation from the straight line expressed as a percentage of the total voltage across the potentiometer. Specification of the potentiometer linearity sets an upper bound on output errors due to non-uniformities in the potentiometer resistance. The actual error due to the potentiometers cannot exceed the sum of the linearity tolerances of the follow-up potentiometer and the computing potentiometer under consideration, and it may be considerably less.

As an example, let us consider a gang of potentiometers in which all the potentiometers have a linearity tolerance of $\pm 1\%$. In Figure 2 we have diagrammed the errors due to three of the potentiometers in this hypothetical gang. In each of the three diagrams in Figure 2 the follow-up potentiometer is the same. The linearity of the follow-up potentiometer is indicated by a dotted curve while each computing potentiometer is shown as a solid curve. Furthermore, the follow-up potentiometer is shown as having the maximum allowable deviation from true linearity. In the top diagram of Figure 2 the computing potentiometer selected conforms almost exactly to the follow-up potentiometer and the error is very small. In the middle diagram the computing pot selected shows remarkable linearity over the greatest portion of its range and yet the error is greater than in the first diagram. The final diagram shows the worst possible case where the error becomes 0.2% at several points.

In any gang of potentiometers some of the computing potentiometers will track the follow-up potentiometer more closely than others, and the output accuracy from these potentiometers will considerably exceed the specified linearity tolerance. Since the potentiometers are the principal determinants of the output accuracy (under static conditions), considerable attention should be

given their selection. If the use of the servomultiplier dictates that the output error *must never exceed 0.25%*, and we are willing to allow 0.05% for servo loop errors, then a gang of 0.1% linearity potentiometers is the minimum that can be accepted for this application. If one is willing to assume that the conformity errors between the two potentiometers are randomly distributed, then the *probable error* (by the method of least squares) of the above system will be 0.15%.

The linearity tolerance of the potentiometer gang is not only the major factor in determining system accuracy, but also the major determinant of the cost of the servomultiplier. In wire wound potentiometers linearities of up to 0.1% may be obtained at nominal cost. Single turn potentiometers having linearity tolerances better than 0.1% can be obtained by a process of selection, but cost is considerably greater than for a standard potentiometer. Where accuracy is more important than speed of response, ten-turn potentiometers can be used. Ten-turn wire wound potentiometers can be obtained with linearities up to 0.025%.

Within the past few months single turn carbon film potentiometers having linearity comparable to ten-turn wire wound potentiometers have become available. While these new potentiometers make it possible to construct high-speed, high-accuracy servomultipliers their cost is three to five times that of an equivalent multi-turn wire-wound potentiometer.

Servo Loop Errors

Let us turn now to investigation of the errors introduced by the servo loop. At this point, it is worthwhile to emphasize the fact that we are concerned with the performance of the servo loop only. We can completely ignore the problem of potentiometer linearity, since the only potentiometer included in the loop is the follow-up potentiometer and the behavior of the system is independent of the linearity of this potentiometer.

Static Error

Before the wiper of the follow-up pot can move, the torque produced by the motor must exceed the system friction torque. In this system the principal cause of friction is the motion of the potentiometer wipers along the coils. This is a form of friction known as "sliding" or coulomb friction as contrasted with viscous friction. The torque produced by viscous friction is directly proportional to velocity. However, the torque produced by coulomb friction is independent of the magnitude of velocity and depends only on its sign. In the absence

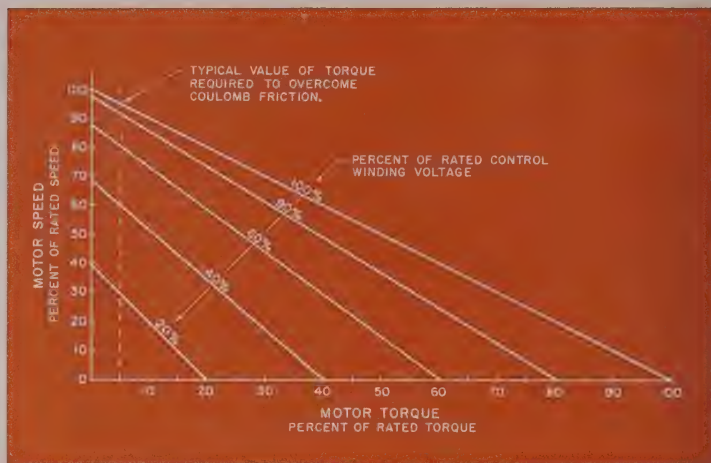


Figure 3. Approximate speed vs. torque curves for a two-phase servo motor.

of coulomb friction, the existence of a motor torque, however small, will result in corrective motion. In other words, the existence of an error signal will cause the potentiometer to turn until the error becomes zero. With coulomb friction, corrective motion will cease when the motor torque is less than or equal to the friction torque. The error voltage, which is just sufficient to cause the motor torque to equal the friction torque, will be the "static error." The static error can be reduced by increasing the amplifier gain, but the gain cannot be increased beyond the point where "hunting" due to finite pot resolution occurs. Consequently, the static error can never be less than the voltage difference between adjacent turns on the follow-up pot. Since the resolution is generally three times better than the linearity tolerance, the error contributed by a well-designed servo loop should be 35 to 50% of the pot linearity tolerance.

Dynamic or Velocity Error

Other errors are introduced when the system is moving. If the input voltage increases linearly with time (i.e., a ramp function) the mechanical system will begin to accelerate as soon as the motor torque exceeds the coulomb friction. As the system accelerates, its velocity increases until the voltage at the wiper of the follow-up potentiometer is increasing as rapidly as the input signal. When this occurs, the acceleration will be zero, the system will be running at a constant velocity, and the only torque required will be that necessary to overcome coulomb friction. Thus, we might expect the error under these conditions to be the same as the static error. In order to explain why this is not so, we must investigate characteristics of the motor.

An ideal servo motor would produce a torque directly proportional to the magnitude of the voltage applied to the control field. This relationship would be independent of the amplitude of the signal or the motor velocity. However, in all real motors, the torque delivered at zero velocity will be limited by saturation of the iron, heating of the windings, and other effects. When a motor is operated within its ratings, the maximum torque it will produce is known as the "stall torque," the torque produced at rated voltage and zero velocity. At any velocity, other than zero, the torque produced will be less than the stall torque and will approach zero as synchronous speed is approached. Due to losses within the motor, the actual no-load speed will be slightly less than synchronous. Since two-phase servo motors have nearly linear speed-torque characteristics, the torque at 100% of rated control winding voltage is generally represented by a straight line passing through zero torque at the no-load speed and maximum, or stall torque, at zero speed.

Assuming a constant voltage on the reference winding, the torque produced at zero velocity will be proportional to the voltage applied to the winding. The curves plotted in figure 3 show that in order to maintain constant output torque as velocity rises, the voltage applied to the control winding must be increased. Furthermore, the necessary increase in voltage will be relatively greater than the increase in velocity, as illustrated by the differing slopes of the curves in figure 3. Since the control winding voltage equals the error voltage multiplied by the gain of the amplifier, the error voltage necessary to

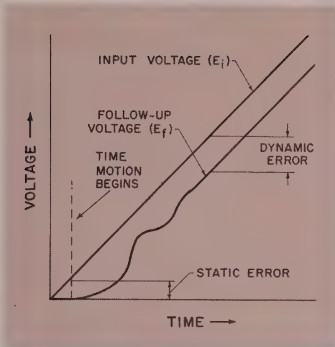


Figure 4. Follow-up voltage with input rising at a constant rate (a ramp function). System is shown starting from a perfect null ($E_i = E_f$); consequently, no motion occurs until E_i reaches the static error voltage.

maintain a given velocity can be calculated when the coulomb friction is known. In figure 3, the intersection of the speed-torque curves with a vertical line erected at the torque required to overcome coulomb friction will indicate the velocity obtained at any control winding voltage.

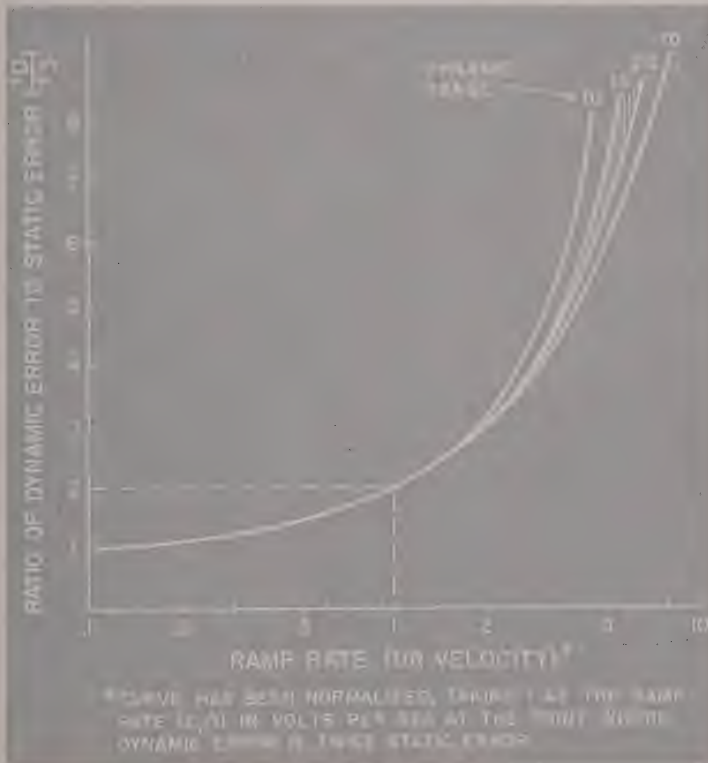


Figure 5. Input ramp rate plotted against dynamic error. See text for explanation of "dynamic range."

In figure 4, an input voltage is shown increasing at a constant rate (known as a ramp rate). When transients subside, the follow-up voltage increases at the same rate and the difference ($E_i - E_f$) is the "dynamic error" at that ramp rate.

If we are given the velocity (or voltage rate) at which the dynamic error equals twice the static error, we can approximate the value of the dynamic error at any other velocity (or voltage rate) by referring to the curves shown in figure 5.

The parameter labeled "dynamic range" is the ratio of the error voltage producing rated torque to the static error voltage. This is equivalent to the ratio of stall torque to friction torque and will generally be between 15 and 20. Thus, the shaded area of the curve applies to most servos. The curve labeled " ∞ " is the limiting case when the friction is zero. The curve labeled "10" shows the deleterious effect of having a low ratio of maximum torque to friction torque.

There are a number of equally convenient and equally appropriate methods for specifying the dynamic error. If the servo is to be used in a particular

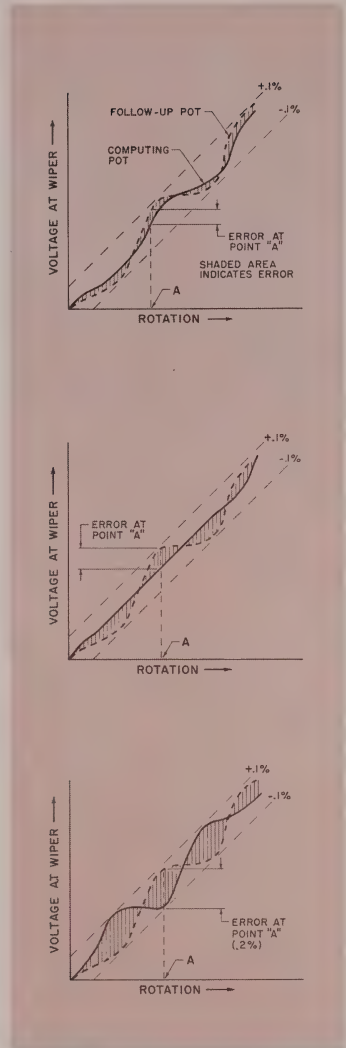


Figure 2. Linearity curves of three $\pm 0.1\%$ computing potentiometers (solid lines) showing how each might track with the same follow-up potentiometer. Note how error indicated by shaded area differs.

application, specification of the maximum dynamic error at a given ramp rate is preferable. For general use, specification of the ramp rate at which the dynamic error is just equal to twice the static error is a reasonable criterion of the system's dynamic performance, because this information provides sufficient data for the approximate calculation of dynamic error at other ramp rates. A statement of dynamic error at an unspecified ramp rate has no meaning whatever.

Speed of Response

Two criteria of response are important: step response and frequency response. In linear systems (particularly systems possessing essentially second order characteristics) the relationship between transient and frequency response can be easily determined. In non-linear systems, this relationship is so complex that it is more convenient to specify both types of response separately. We will consider frequency response, then step response, and finally, the interrelationship between the two.

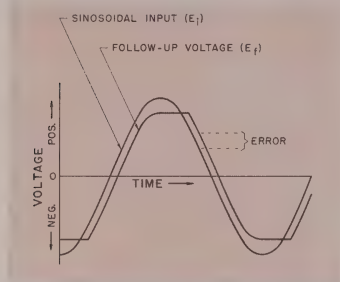


Figure 6. Relationship between input and follow-up voltages at very low frequency. Error is exaggerated to show manner in which follow-up voltage differs from sinusoidal input.

Frequency Response

When the input signal varies sinusoidally with time the follow-up voltage will also be approximately sinusoidal. Figure 6 shows input and follow-up waveforms at such a low frequency that the total error is simply the static error of the system. The frequency response characteristics of the system refer to the manner in which the follow-up voltage varies both in magnitude and phase as the input signal is varied in frequency. A typical frequency response curve is shown in the top graph of figure 7. While it is sufficient in many applications to show only the amplitude curve,* the phase characteristics also shown are extremely important in computer work. If we assume that the input and follow-up voltage are identical in amplitude but differ only in phase, the following formula defines the loop error at the point in each cycle where the error is greatest:

$$\text{Max. loop error} = 2E_i \sin \frac{2}{\phi}$$

where ϕ = Phase lag

With ϕ equal to 11 degrees and $E_i = 10$ volts peak (10% of full scale) the maximum loop error is 0.2 volts or $\pm 1.0\%$!

*Specification of the gain is sufficient to determine the phase in a minimum phase system.⁶

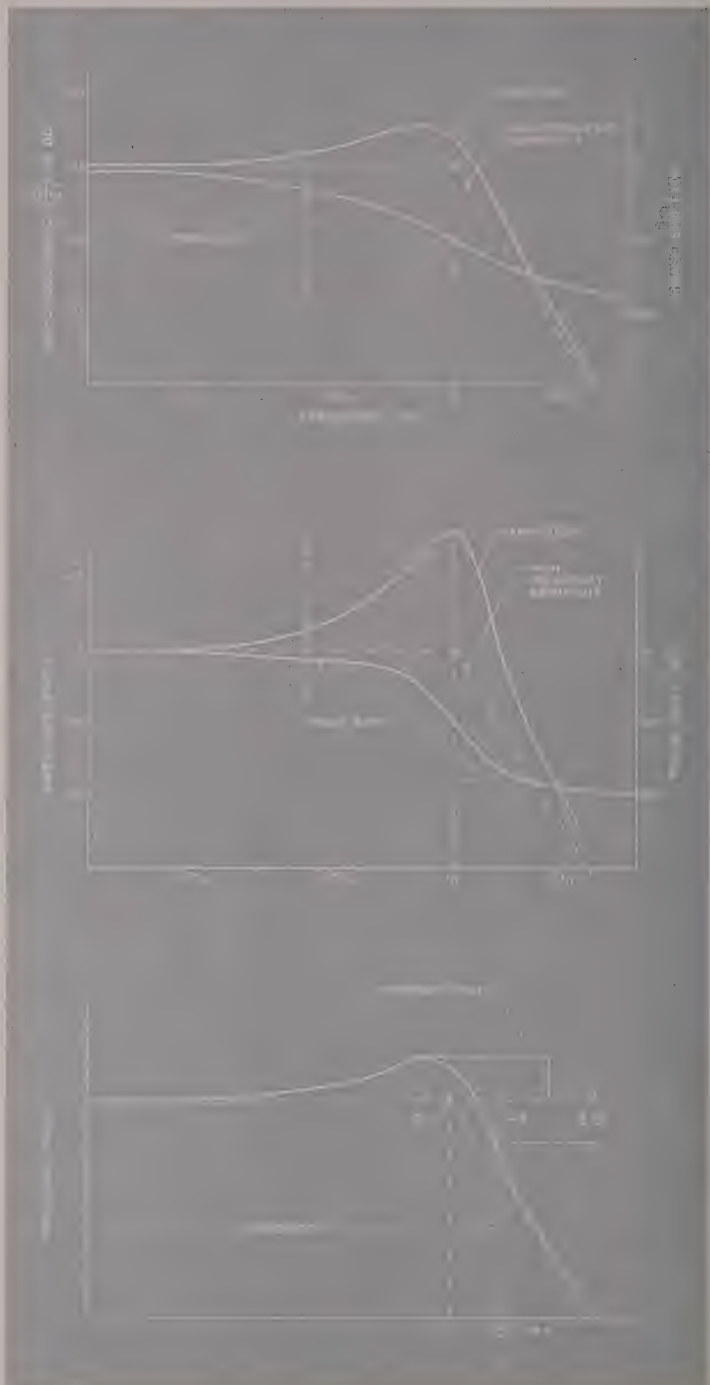


Figure 7. Frequency response curves. Two top graphs show response of servo loop with two different degrees of damping. With low damping, the system is less stable as shown in the middle graph, but accuracy up the frequency f_1 is higher.

This indicates the importance of paying particular attention to the phase characteristics when accuracy is essential. Referring again to Figure 7, we see that from an accuracy standpoint it is the phase shift rather than the amplitude that determines the system frequency limitation. When the system damping factor is lowered, the phase shift at a given frequency can be reduced but the amplitude resonant rise is greatly increased, as shown in the middle graph of Figure 7. While this system has undesirable characteristics above the frequency f_1 , it will have superior accuracy to the system shown in the top graph at frequencies below f_1 . Certain of the system characteristics are described by the points labeled A and B in the bottom graph of Figure 7. Point A where the system gain has dropped 3 db is generally used to specify the system bandwidth as indicated. (Note that, even neglecting phase shift, and output 3 db down is about 30% in error. The specified bandwidth is not the useful frequency range for computing work). The frequency determined by the intersection of the high and low frequency asymptotes (indicated by point B) is the resonant or natural frequency (f_0) of the system. This frequency is often termed the "corner frequency" in servo work.

Step Response

The second criterion of the loop performance will be its response to a sudden or step change in the input signal. In considering transient or step response, maximum overshoot, rise time and settling time are the commonly specified criteria. The following definitions have been quoted from reference No. 7. The rise time is usually defined either as the time required for the follow-up voltage to go from 10% to 90% of its final value, or as the reciprocal of the slope of the response curve at the instant E_t is half its final value. (The reciprocal of the slope is the time that would be required for E_t to go from 0% to 100% of its final value if it increased linearly at the rate it reaches at the 50% point.) The settling time is usually defined as the time required for the oscillation of the response to decrease to less than a specified percentage of the final value; 5% and 2% are common criteria. The overshoot expressed as a percentage of the final value is a measure of the relative stability of the system.

Due to non-linearities the transient response of the servo will depend on the

magnitude of the input step. If the input step is very small, the torque produced by the motor will be proportional to the magnitude of the step and the response will be approximately the same regardless of the amplitude of the step. In this case only the presence of coulomb friction prevents complete linearity. When the input step is of sufficient magnitude to produce rated voltage at the motor control winding, further increase in the magnitude of the step will no longer produce an increase in motor torque. At this point the system has reached its "acceleration limit" as shown in figure 8. Maximum acceleration actually occurs only at the instant when the velocity is zero. As the velocity increases, the motor torque decreases as shown previously in Figure 3. If the magnitude of the step is quite large, the motor torque will continue to decrease as the velocity increases until it is just sufficient to overcome the coulomb friction. When this occurs there is no longer any torque available to accelerate the load and the system has reached its "velocity limit" as shown in Figure 9.

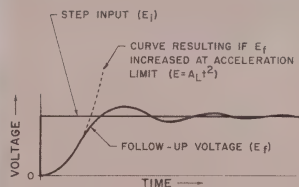


Figure 8. Response of servo loop to step input large enough to produce maximum acceleration but small enough so that servo does not reach the "velocity limit." In this case the rise time is determined primarily by the "acceleration limit."

When a system responds at its acceleration limit, the rise time (T_r) will be

$$T_r = \frac{\sqrt{2}}{2} \sqrt{\frac{E_i}{A_L}}$$

where

E_i = input step voltage

A_L = acceleration limit in volts/sec²

Knowledge of these limits allows us to calculate the best possible step response.



Figure 9. Response of servo loop to a large step input. Rise time is determined primarily by the "velocity limit" of the system.

In a well designed system the response will closely approach the limits of velocity and acceleration, but specified limits, per se, do not insure any particular rise time.

The restrictions on transient response imposed by velocity and acceleration limits apply equally well to the system frequency response. When the input voltage varies sinusoidally the voltage at the follow-up pot would ideally vary according to the following equation:

$$E_t = E_p \sin 2\pi ft$$

where E_t = follow-up voltage at time t

E_p = peak value of input voltage

f = frequency in cps

t = time

To satisfy this equation E_t must have a peak velocity $V_p = 2\pi f E_p$ volts/sec and a peak acceleration $A_p = (2\pi f)^2 E_p$ volts/sec². If necessary peak velocity exceeds the "velocity limit" or required peak acceleration exceeds the "acceleration limit," distortion will occur with resulting inaccuracies. Given the velocity and acceleration limits, one can calculate the maximum peak input voltage at any frequency if the servo is to operate without distortion. Figure 10 is a graph which may help in this calculation. At any frequency and peak input value to the right of the lines representing velocity and acceleration limits some distortion will occur. To take an example, suppose a given servo has a velocity limit, $V_L = 1000$ volts/sec and an acceleration limit $A_L = 20,000$ volts/sec². In this case, "1" on the frequency scale would equal $20,000/1000$ or 20 cps and "1" on the voltage scale would equal

1000²/20,000 or 50 volts. Now, suppose we wish to know the highest frequency at which a 100-volt peak signal might be followed without distortion. We see that "2" (or 100 volts) on the voltage scale corresponds to ".08" or 1.6 cps on the frequency scale. Note also that the response is velocity limited.

By applying a square wave of the proper frequency, the servo can be forced to operate very nearly at either the velocity or acceleration limit. In the former case, the output will be a triangular wave and in the latter case, a parabolic waveform will result. The peak amplitude vs. frequency characteristics in this instance are shown as the dotted curves in figure 10. It is important to note that the output *wave form* under "forced response" is far different from the input waveform.

The frequency-amplitude maximums determined by the use of figure 10 are those imposed by velocity and acceleration limits alone; other characteristics of the servo loop may limit response further. One important characteristic of the system is the carrier frequency. Even if velocity and acceleration limits did not confine the frequency response, the bandwidth would not exceed approximately 60% of the carrier frequency. Thus, the commonly used 60 cps carrier limits the bandwidth to about 35 cps. With a bandwidth of 35 cps the rise time is limited to approximately 15 milliseconds as demonstrated below. A 400 cps carrier is required to achieve an appreciably faster response than this.

If the transient response has less than 10% overshoot, the product of the rise time and the system bandwidth will be approximately constant⁸ and we can write:

$$T_r = \frac{0.45}{B}$$

where B = bandwidth in cps

The existence of non-linearities in the system makes it necessary to determine T_r and B separately for each given signal amplitude. The higher the system bandwidth, the more rapid will be its response to a sudden change in the input voltage and, conversely, the specification of a small rise time is tantamount to specifying a large bandwidth. The transient overshoot is related to the maximum resonant rise; the greater the resonant rise, the greater will be the overshoot. Since the settling time is dependent on both the degree of stability and the rise time, both the bandwidth and the resonant rise are involved. In

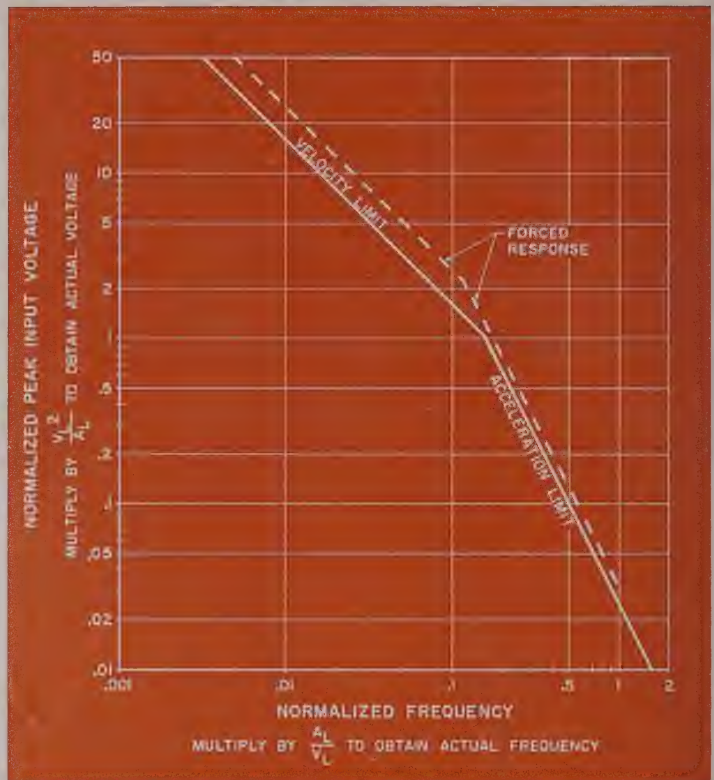


Figure 10. Graph for determining limitations imposed on input amplitude and frequency by acceleration limit (A_L) and velocity limit (V_L). In the area to the right of the limit lines the follow-up voltage wave will be distorted. In the area to the left distortion will not occur except insofar as other characteristics of the servo loop impair response.

general, if two systems have approximately equivalent bandwidths, the one having the smallest resonant rise will have the shortest settling time.

Conclusion

The servomultiplier is inherently a low speed device and it is not intended for use in problems requiring a rapid rate of response. Where the problem variables have frequency components not exceeding one or two cycles per second, the servomultiplier is an accurate, reliable and economical element. In spe-

cifying and evaluating the performance of a servomultiplier we must insure that the accuracy obtained will be sufficient for the intended use. The transient and frequency response characteristics will determine the time scale required for the solution of a particular problem. In general we can trade reduced speed for increased accuracy without impairing the economy or reliability of the device. If we attempt to increase the speed of response beyond the limits imposed by the available mechanical components, we sacrifice both accuracy and economy.

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PERFORMANCE SPECIFICATIONS FOR BERKELEY MODEL 1191

SERVOMULTIPLIER

(For complete specifications write for
"Technical Bulletin, Model 1191")

INPUT

Into servo:

$$-100 \leq X \leq 100 \text{ volts}$$

Into each of five computing pots:

$$Y \text{ and } -Y, -100 \leq Y \leq +100 \text{ volts. (External inverter required to generate } -Y \text{ from } Y.)$$

OUTPUT

Five products:

$$\frac{XY_1}{R}, \frac{XY_2}{R}, \frac{XY_3}{R}, \frac{XY_4}{R}, \frac{XY_5}{R}$$

R (the reference voltage) is normally 100 volts. As many as three computing pots may be sine-cosine resolvers, thus producing the following outputs:

$$\frac{XY_1}{R}, \frac{XY_2}{R}, \frac{X \sin Y_3}{R}, \frac{X \cos Y_3}{R},$$

$$\frac{X \sin Y_4}{R}, \frac{X \cos Y_4}{R}, \frac{X \sin Y_5}{R}, \frac{X \cos Y_5}{R}$$

COMPUTING POTENTIOMETER SPECIFICATIONS

The potentiometer assembly consists of six type LSP 3"-diameter wire-wound Helipot with ball bearings. Total resistance is 50K ohms $\pm 5\%$ (20K ohms per quadrant on resolvers). Three taps: 2 ends and center; center tap accuracy $\pm 0.1\%$. Linearity $\pm 0.1\%$ (0.5% conformity, peak-to-peak, on resolvers). Extra taps up to 33 total per pot are available at extra cost.

SERVO LOOP PERFORMANCE

Static accuracy: $\pm 0.5\%$

Dynamic Accuracy:

$$\pm 0.1\% \text{ at } 75 \text{ volts per second.}$$

Response to 10-volt step input:

Rise time: 20 milliseconds to go from 10% to 90% of final value.

Settling time: 60 milliseconds to remain within 5% of final value.

Overshoot: 1.5 volts (1.2db)

Response to 100-volt step input.

Rise time: 85 milliseconds to go from 10% to 90% of final value.

Settling time: 175 milliseconds to remain within 5% of final value.

Overshoot: 15 volts (1.2db)

Frequency response at 10% of full scale amplitude (20 volts peak-to-peak):

Amplitude curve is flat within $\pm 1\text{db}$ to 6 cps.

Phase shift is 5 degrees at 6 cps.

Velocity limit:

1150 volts per second

Acceleration limit

Greater than 31,000 volts/sec²

NEW LOW COST COUNTERS OPERATE WITH PRINTERS

By severing the time base from its well-known Universal EPUT* and Timer, Berkeley now offers for the first time two low cost counters capable of operating with digital printers. All previous counters designed for use with printers included time devices of some type.

Although designed for accurate, high or low speed measurements not involving time, neither the Model 7050 nor the Model 7060 is restricted to this function. Both can accept time signals from external sources. In effect, this combination results in a Universal EPUT* and Timer.

GATE CONTROL

Models 7050 and 7060 feature either a manually or electronically controlled gate. A function switch permits choice of several circuit arrangements that allow gate control from a manual on-off switch, from start-stop signals applied to a second input amplifier, or from start and stop signals applied to separate start and stop amplifiers.

Gate control signals, which turn the decimal counting units off and on, may be of any frequency from dc to the maximum counting rate of the instrument (100 kc for the 7050, 1 megacycle for the 7060).

No restriction is placed on input waveform and measurements are displayed in direct decimal form.

ELECTRONIC RESET

These economical instruments also feature electronic reset and manual reset from a front panel push button

switch. Using manual reset, the counter accumulates counts whenever the manual "count on-off" switch is in the "on" position.

Both models are designed for use with the Berkeley Model 1452 Digital Printer. It prints automatically each time the switch is returned to the "off" position, giving the cumulative total at each print.

By making a simple internal wiring change, Models 7050 and 7060 become cumulative counters when electronic gating is used. This feature, plus the manually controlled gate, make the instruments ideally suited for applications as nuclear counters.

STEEL MILL APPLICATION

As a typical example of applications possible with the new counters, consider a steel mill processing line where a sheet of steel is drawn by a roller. Thickness of the sheet varies from point to point; this ratio must be known to control the size of the sheet.

By generating a frequency proportional to the linear rate of work travel and using the Model 7050 to measure ratio of the two frequencies, the thickness ratio of the steel plate is determined.

Models 7050 and 7060 find excellent application as slave EPUTs (as in multiple tachometry installations requiring speed measurements) and as slave time interval meters. Digital phase measurements also can be performed.

Models 7050 and 7060 are now in production at Berkeley's Richmond plant. Prices and further information — technical bulletins — available on request.



NEW LITERATURE

A four-page bulletin, "Frequency Measuring Equipment," describes the operation and design of Berkeley's Model 5571 frequency meter and time interval meter. The bulletin includes information on the Model 5580 reference generator and plug-in units capable of extending frequency range to 1005 mc. Specifications, price information, and typical applications are listed in the bulletin. Valuable information for those concerned with high precision frequency and time measurements in both high and low ranges.

OTHER NEW LITERATURE

General Facilities Report — A 24-page brochure, illustrated with numerous photographs of production, engineering, and equipment facilities at Berkeley's modern Richmond factory.

Data Handling System — Bulletin 5780 describes data handling system featuring high speed storage on magnetic tape, playback into electric typewriter or summary punch, and continuous time readout.

Data File 123 — This paper, "Analog Computer Solutions for Feedback Control Systems," discusses briefly computer capabilities, limitations, and applications as an introduction to two detailed examples — reactor power plant

design and petroleum fractionating tower design. Techniques described in each example apply to many engineering problems.

Supplementary Servicing Notes on Models 7150, 7160 and 7250, 7260, 7350 and 7360: Write for "Supplementary Servicing Notes, SSN7000."

To obtain copies of any Berkeley literature, please contact your nearest Berkeley sales representative or write to Berkeley Division, Beckman Instruments, 2200 Wright Ave., Richmond 3, California.

BERKELEY GROWTH CONTINUES AT RAPID PACE

Berkeley Division of Beckman Instruments, Inc., begins its second decade of operation this year as a mass producer of more than 300 types of electronic counting, control and computing equipment.

Berkeley's factory in Richmond, California, occupies 105,000 square feet of floor space and employs 750 men and women. A factory expansion program scheduled this year will more than triple production capacity.

Standard Berkeley instruments fall into three general categories—counting, timing, and frequency measuring equipment; analog computers, and nuclear test instruments.

Berkeley's engineering department, staffed with 150 engineers and technicians, maintains a continuous research and development program. Important electronic "firsts" resulting from this program include:

- ★ The first console style push-button analog computer (EASE*)
- ★ The first direct reading time interval meter for counting up to a million events per second.
- ★ The FERRISTOR*, a small magnetic amplifier that replaces vacuum tubes.
- ★ The first 1,000,000-counts per second events-per-unit-time meter (EPUT*).
- ★ The original electronic decade unit (DCU).
- ★ The first in-line, in-plane digital indicator (readout).

For customers requiring special instruments and simple and complex systems, Berkeley maintains a complete systems department. Its staff includes specialists in all major fields of electronic interest.

Since 1952, Berkeley has been a division of Beckman Instruments, Inc., itself a leader in the electronics field. With Beckman's support, Berkeley has been able to pursue its research and development program successfully and to expand its facilities whenever needed.



*Trademark

DEVIL'S DICTIONARY OF SERVO TERMS

(Despite our efforts to trace him, the wag who penned these irascible lines remains anonymous.)

SERVOMECHANISM: A system, usually of great complexity, in which the output of a device is sampled and fed back into the input in order to produce uncontrollable oscillations.

FEEDBACK LOOP: That portion of a servomechanism circuit which makes possible its instability.

FOLLOW-UP: A device in a servomechanism which is used to follow, as faithfully as possible, its oscillations.

RATE GENERATOR: A small but costly electrical device affixed to the output end of a servo system for ornamental purposes.

STABILITY: The desired optimum of servo performance, as manifested by violent threshing of an output member.

AMPLIFIER: An electronic device for superimposing electrical instabilities on mechanical.

SPECIFICATION: A form of heroic or epic poetry favored by engineers; a collection of impossible conditions; a collection of loopholes loosely held together by wistful verbiage.

ZERO BACK-LASH: A whimsical concept much professed by authors of specifications.

NYQUIST DIAGRAM: An ornamental figure derived from mathematics which demonstrates the stability of an obviously unstable system.

WIRING DIAGRAM: A form of the graphic arts which has the characteristic of changing form constantly in the manner of cloud formations.

PRODUCTION (With respect to servo electronics): The process of painfully assembling, dismantling and reassembling electrical components in accordance with wiring diagrams (q. v.); a vicious circle.

SERVOMECHANISMS ENGINEER: A soothsayer of mystical powers skilled in mathematical rubrics and incantations; a prophet without honor in California or anywhere else, a dreamer or woolgatherer.

PERFORMANCE EVALUATION: A grateful appreciation of whatever results from a servo system.



summer, 1957

short form catalog c-704

Berkeley digital and analog instrumentation

COUNTING, TIMING, FREQUENCY MEASURING EQUIPMENT

- EPUT® Meters • Universal EPUT® Meters • Frequency Measuring Equipment • Preset Counter Controllers • Time Interval Meters • Electronic Counters • Nuclear Scalers and Count Rate Meters • Digital Recorders • Inline Readouts • Transducers • Decimal Counting Units

SPECIAL AND GENERAL PURPOSE TEST INSTRUMENTS

- Expanded Scale Volt Meters • Expanded Scale Frequency Meters • Resistance Bridges • Double Pulse Generators

EASE* ANALOG COMPUTERS AND EASE* PRECISION COMPONENTS FOR CONTROL SYSTEMS

*T.M.

Beckman®

Berkeley Division

A Division of Beckman Instruments, Inc.

2200 Wright Avenue, Richmond, California

Phone LAndscape 6-7730 TWX Richmond 433

Beckman/Berkeley Division, now in its second decade, supplies industry and science throughout the world with two hundred types of electronic counting, control and computing equipment. An organization of highly skilled and experienced engineers, designers and production workers, Berkeley is equipped to mass produce a wide range of instruments for science and industry. Techniques for the mass production and assembly of high speed counters, timers and frequency measuring equipment originated at Berkeley.

Facilities at Berkeley are by no means limited to quantity production of standard type instruments. The Engineering Department conducts research development and product design operations in four major fields of electronic interest—counting,

timing, and frequency measuring equipment, analog computers, nuclear test instruments and special products.

Naturally this stress on research and development has resulted in important electronic "firsts" at Berkeley. Some of these include:

- The first 1,000,000 count per second events-per-unit-time meter (EPUT®)
- The original electronic decade unit (DCU)
- The first direct reading time interval meter for measuring time intervals to one microsecond.
- The first console style push-button analog computer (EASE*)
- The first direct reading frequency meter
- The first digital recorder with printed readout
- The first in-line, in-plane digital indicator
- The FERRISTOR®, miniature vacuum tube replacement

* EPUT® meters

Berkeley EPUT® Meters automatically count and display the number of events that occur during a precise time interval. Events may be any physical occurrences that can be represented by changing voltages occurring either regularly or at random rates to 1,000,000 per second.



New Model 5210 100KC EPUT® Meter for industrial and field application. Light, small, portable. Simple to operate. Straightforward design and construction. Reliable. The 5200 Series use same DCUs as other Berkeley equipment.



7000 Series units may be used to measure frequency or period, and also as high speed electronic counters with manual on-off control. Model 7160 shown.

APPLICATIONS

Precision tachometry; measurement of pressure, flow, temperature, viscosity, velocity, frequency, frequency period; process control or data reduction systems; calibration of frequency generating equipment; measurement of any electrical, mechanical, optical or other physical event occurring during a precise time interval.

BRIEF SPECIFICATIONS	Model 5210	Model 7150	Model 7151	Model 7160	Model 7161	Model 7650
Count Capacity:	4 digits	5 digits	5 digits	6 digits	6 digits	5 digits
Count Rate:	0 cps to 100 KC	0 cps to 100 KC	0 cps to 100 KC	0 cps to 1 mc	0 cps to 1 mc	0-40,000 cps
Time Bases: (decade steps)	0.1 and 1 sec	10 μ sec to 1 sec	Time Interval Generator	1 μ sec to 1 sec	Time Interval Generator	0.1 to 10 sec
Binary coded output to drive digital printer	optional \$30.00 extra	yes	yes	yes	yes	yes
Price:	\$475.00	\$775.00	\$1195.00	\$995.00	\$1345.00	\$1495.00



New Models 7151 and 7161 Preset EPUT® Meters feature a variable time base. Time base dividers have been replaced by preset DCUs. In addition to specifications below, these instruments feature several unique operating functions: Totalize — divides frequency between 0 and 10 KC by any number from 1 to 10,000; TIG — generates frequencies from 0.1 to 10⁴ milliseconds.



Model 7650 Long Life Magnetic EPUT® Meter performs the same function as models described above. Uses Berkeley FERRISTORS® in all critical circuits to assure continuous-duty reliability. Ideally suited to industrial test applications such as jet and piston-engine test cells, etc. Has digital "count-down" time base for precise gating; no adjustment of time base required.

*T.M.

These truly universal instruments combine high-speed electronic counting with a precision time base in multi-purpose circuitry. They function as counters, timers, time-interval meters, EPUT® meters, frequency, frequency ratio or period meters, or as secondary frequency standards.

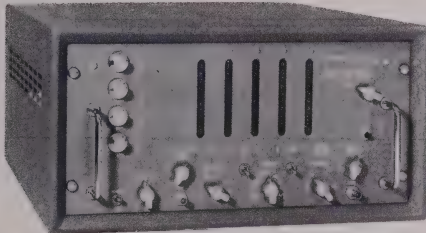
APPLICATIONS

Counting, time interval, events-per-unit time measurements for precision tachometry, measurement of pressure, flow, frequency, velocity, viscosity, elasticity; timing relay, shutter action, etc. Measurement of unknown frequencies, frequency ratios, periods, etc.



New Model 5230 100 kc Universal EPUT® Meter for industrial and field application. Light, small, portable. Simple to operate. Straightforward design and construction. Reliable. The 5200 Series uses same DCUs as other Berkeley equipment.

BRIEF SPECIFICATIONS	Model 5230	Model 7350	Model 7351	Model 7360	Model 7361
Ranges-Frequency:	0 cps to 100 kc	0 cps to 100 kc	0 cps to 100 kc	0 cps to 1 mc	0 cps to 1 mc
Time Interval:	100 μ sec to 10 ⁴ sec	10 μ sec to 10 ⁶ sec	10 μ sec to 10 ² sec	1 μ sec to 10 ⁷ sec	10 μ sec to 10 ³ sec
Period:	0 cps to 10 kc	0 cps to 100 kc	0 cps to 10 kc	0 cps to 1 mc	0 cps to 10 kc
Time Bases:	0.1 and 1 sec	10 μ sec to 10 sec	Time Interval Generator	1 μ sec to 10 sec	Time Interval Generator
Binary coded output information for driving digital recorder	\$30.00 extra	yes	yes	yes	yes
Price:	\$575.00	\$945.00	\$1295.00	\$1245.00	\$1445.00



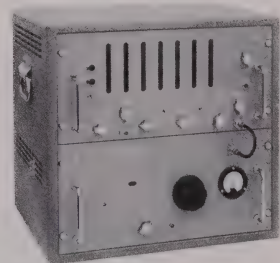
New Models 7351 and 7361 Preset Universal EPUT® Meters features are similar to Models 7150 and 7160 with variable time base feature, etc. In addition, TIM and A/B functions are offered.



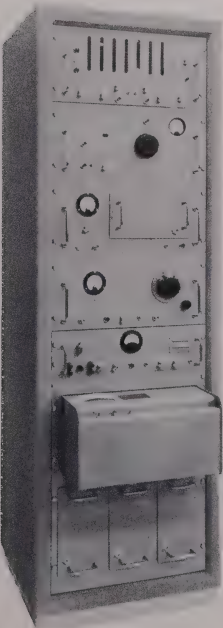
Model 7360 Universal EPUT® and Timer.

Frequency Measuring Equipment

Basic instrument is the Model 5571, capable of measuring frequencies from 0 cps to 42 mc. Addition of the Model 5580 UHF-VHF converter and suitable plug-ins extends the range to 515 mc; Model 5582B VHF converter with plug-ins extends the range to 1,005 mc. Results are displayed in direct-reading digital form. Unit will drive a Model 1452 digital printer to provide a complete frequency logging system in which results are printed on standard adding machine tape. Model 5571 is also a Universal EPUT® Meter with same specifications as Model 7360.



Model 5571 with 5580 converter and 5580 series plug-ins for frequencies to 515 mc. Model 5571 price, \$1825. Model 5580 converter, \$300.00. 5581 series plug-ins, \$125.00 to \$175.00 each. All are FCC-approved. Model 5571 shown.



New Model 905 WWV receiver is most convenient, reliable method of utilizing standard time and frequency broadcasts from NBS stations WWV and WWVH. Features: covers all six WWV and WWVH frequencies, crystal controlled, separate crystal for each channel, built-in audio filters. Price: \$525.00 (Rack) \$550.00 (Cabinet).

Complete frequency logging system for frequencies to 1,000 mc. Model 5571 (with 5582B converter and plug-ins), drives Model 1452 digital printer to record results automatically on adding machine tape, 905 WWV receiver.



Time Interval Meters

Any event delineated by varying voltages may be timed. All models may be standardized against WWV or other external standards. Provisions are also made to measure period of input signals, use as a high-speed electronic counter, or frequency ratio meter.

APPLICATIONS

Timing of relays, shutters, solenoids, controls; ballistics research; measurement of viscosity, elasticity, velocity; accurate low frequency and period measurements, frequency ratio measurements, etc.

BRIEF SPECIFICATIONS	Model 5220	Model 7250	Model 7260
Range:	100 μ sec to 1 sec	10 μ sec to 1 sec	1 μ sec to 1 sec
Accuracy:	$\pm 100 \mu$ sec ± 1 part in 10^4	$\pm 10 \mu$ sec, ± 1 part in 10^5	$\pm 1 \mu$ sec, ± 1 part in 10^6
Input Requirements:	0.25v rms, 1 megohm dc-coupled.	0.1v rms, 10 megohms, ac or dc-coupled.	
Display Time:	Adjustable .05 to 5 sec.	Adjustable, 0.1 to 10 seconds (automatic reset). Manual reset also provided.	
Binary-coded output to drive Digital Printer	Optional \$30.00 extra	yes	yes
Price: (f.o.b. Factory)	\$475.00	\$595.00	\$830.00



New Model 5220 100 μ sec to 1 sec time interval meter for industrial and field applications.



Model 7250 Berkeley Time Interval Meters provide a direct digital reading of elapsed time between any two events, or the duration of a single event, in microsecond (Model 7260) or 10-microsecond increments.

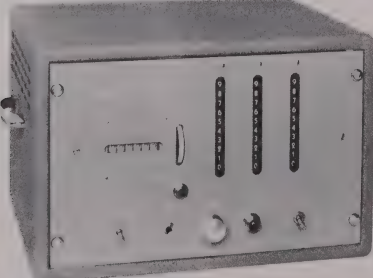


Electronic Counters



Model 5001 (125 cps) industrial type electronic counter for use where speed requirements are in excess of the limitations on mechanical registers (10 cps).

BRIEF SPECIFICATIONS	Model 5001	Model 5010	Model 7050	Model 7060
Counting Rate:	0-125 cps	0-10,000 cps	0-100KC	0-1 mc
Sensitivity:	0.5 volts peak	0.5 volts peak	0.1 volts rms.	0.1 volts rms
Binary coded output to drive Digital Printer	no	no	yes	yes
Price:	\$195.00	\$330.00	\$545.00	\$645.00



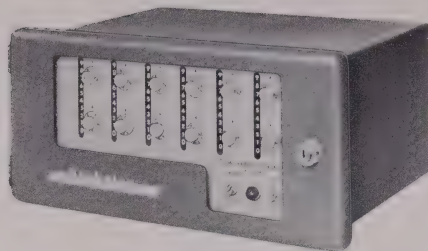
The Berkeley Industrial Counter, Model 5010 (10 KC), is a highspeed electronic counting instrument designed to fill general counting needs, where speed requirements are greatly in excess of those possible with mechanical counters.



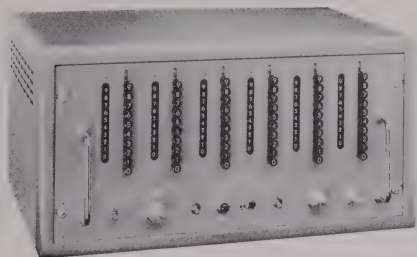
New Models 7050 (100 kc) and 7060 (1mc) gating counters offer both manual and electronic gating. Gate control signals may be of any frequency from d-c to maximum counting rate of the instrument with no input waveform restrictions. For use as frequency ratio meters, digital flow computers, slave EPUT® or time interval meters, high speed counters. Shown Model 7060.

Preset Counter-Controllers

Counts at rates to 40,000 cps, yields output signals at any desired preset total (or any two preset counts with dual preset models). Operates on input pulse of ± 1 volt peak, or more. Instantaneous reset to zero after final count. Reliable, simple to operate. Available in 2, 3, 4, 5, and 6-digit capacities. Long-life magnetic Model 5840 dual preset features FERRISTOR* circuitry for continuous-duty reliability. Typical applications: coil winding, automatic packaging, sorting to length, motor speed control.



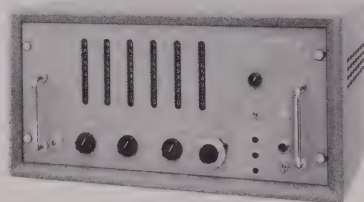
Series 5840 long-life magnetic dual preset counter features FERRISTOR* circuitry; 4-digit, \$1115.00; 5-digit, \$1200.00; 6-digit, \$1295.00.



Series 5420 single preset models range in price from \$435.00 for 2-digit capacity to \$740.00 for 6-digit capacity. Dual preset Series 5440 range from \$650.00 (2-digit) to \$895.00 (6-digit).

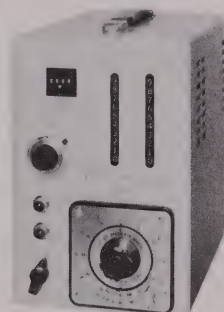
Nuclear Scalers

Berkeley's long experience in counting techniques has been carried over to the nuclear field to produce a line of high quality scalars. Model 2025, basically a gated decimal counter, will count, store and record any phenomena occurring in a random fashion. It features automatic reset and start, uses DCUs instead of mechanical registers, and is designed for use with an electronic timer (Model 811) for increased accuracy.



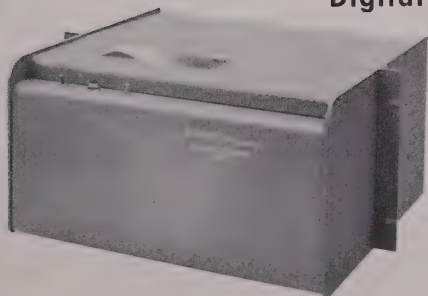
BRIEF SPECIFICATIONS	
Model 2025	
Input:	Pulse Height discriminator with range +5 to +50 volts
Scaling Circuit:	Paired Pulse Resolution: Better than 1 μ sec
Integral Amplifiers:	Input Sensitivity: 1 millivolt $\pm$ 20%
Controls:	Preset Count Selector — 100 to 4 million in 1-2-4 steps
Price:	\$950

BRIEF SPECIFICATIONS	
Model 2101	
Input Sensitivity:	0.25 volts
Resolving Time:	5 μ seconds
Reset:	Reset of register and counting units by single lever
Timer:	Indicates and times automatically to closest second up to 60 min. Accuracy $\pm$ 0.2 sec
Price:	\$595.00

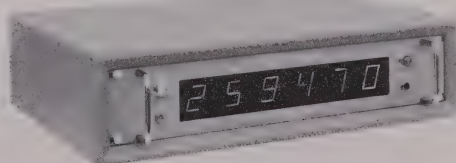


This scalar weighs only 24 pounds and offers maximum convenience for laboratory work and medical diagnosis. Can be used directly with G-M tubes and scintillation counters. Extremely reliable and simple to operate.

Digital Recorders, Inline Readouts & Transducers



MODEL 1452 DIGITAL PRINTER. Automatically and permanently records information from any Berkeley 5510, 5571 or 7000 Series instrument, prints data in digital form on standard adding machine tape from printer and scanner in one compact unit. May be modified to print "Time" or "Code" information simultaneously with data. Rack or bench mounted; available in up to 8 digits. One printout every 0.85 seconds. Price (6-digit), \$950.00.



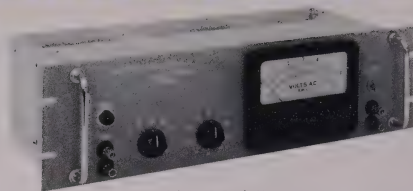
MODEL 5916 IN-LINE READOUT. Large, illuminated in-line IN-PLANE figures reduce fatigue and error. Ideal for remote observation of data. Connects directly to any Berkeley 5510, 5571 or 7000 Series instrument. Presentation rate up to 15 per second; accepts binary voltages. Price \$775.00.

TRANSDUCERS. A large number of transducers especially designed for use with Berkeley counting, timing, and frequency measuring equipment are available. These include tachometer, pickups, photocells, and light sources. Specifications and technical description on request.

SPECIAL AND GENERAL PURPOSE TEST INSTRUMENTS



Expanded Scale Voltmeter



Model 101R Rack Mount.

Model 101-50 expanded scale voltmeter. Featuring: $\pm 0.25\%$ accuracy, true rms reading, easy to read expanded scale, direct connection for 1 MA recorder.

Brief Specifications: Accuracy— $\pm 0.25\%$ of input voltage; Voltage Indicated—True rms; Voltage Range—100-500 (50-250v); Frequency Range —50-2,000 cps; Scale Range—12v (6v); Price: \$360.00 (rack mounted \$400.00).



Expanded Scale Frequency Meter

Expanded Scale Frequency Meters are designed for fast accurate monitoring of frequencies near 400 cps. They were originally intended for use in making production inspection measurements of the frequency regulation of motor and engine driven generating units, but many other applications where a record of frequency is desired have been found.



The Model 100 Transformation Ratio Meter is an RMS reading expanded scale voltmeter designed to read the primary and secondary voltages of synchros faster and easier than by conventional methods. The method of operation is ideally suited for production testing as well as for inspection of synchros and control transformers. Features: $\pm 0.2\%$ Accuracy; RMS Reading; Expanded Scale; Read Directly in % Deviation; Simple To Operate For Rapid Production Checks. Price \$400.00.

The Model 404 expanded scale frequency meter features Accuracy of $\pm \frac{1}{2}$ cycle, 1 MA Recorder Connection Provided; Expanded Scale for easy, error-free reading. Brief Specifications: Base Frequency—400 cps; Span— ± 25 cycles; Accuracy— $\pm \frac{1}{2}$ cycle; Price—\$330.00 (rack mount \$380.00).



Wide Range Resistance Bridge

The Model 605 wide range resistance bridge provides a means for rapidly and easily checking resistances to a high degree of accuracy. Seven ranges for full scale resistance values are selectable by front panel push button switches. Features: 5 ohms to 100 megohms, push button operation, high accuracy, negligible drift.



Brief Specifications: Resistance Scales—100, 1K, 10K, 100K, 1M, 10M, 100M, Full Scale; Accuracy— $\pm (.15\%$ of resistance measured $+ .05\%$ Full Scale); Drift—Negligible after 30 minute warm-up; Batteries—1-45 Volt, 2-7 $\frac{1}{2}$ Volt; Price—\$170.00.



Berkeley Double Pulse Generators



Model 4904 Double Pulse Generator

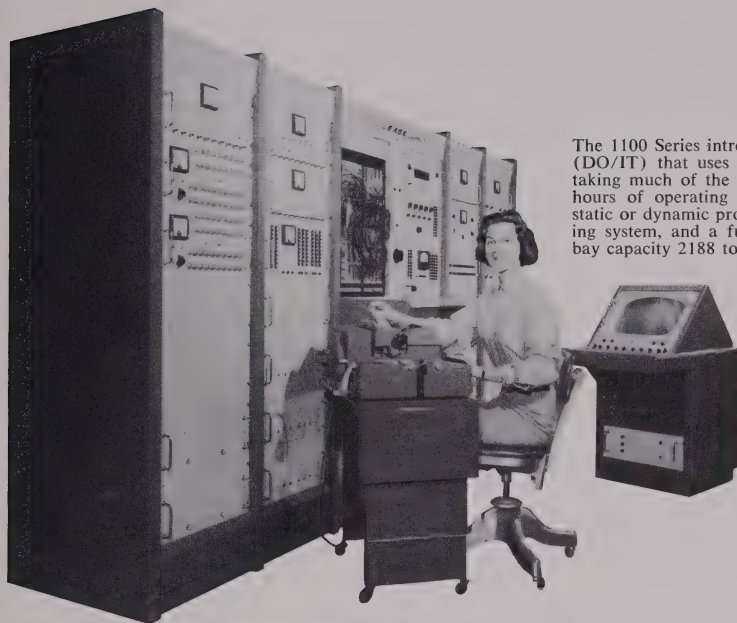
BRIEF SPECIFICATIONS	Model 903	Model 4904
Pulse Width:	0.15 to 1.8 μ sec	0.3 to 10 μ sec
Rise Time:	0.035 μ sec	0.08 μ sec
Decay Time:	0.15 μ sec	0.26 μ sec
Pulse Spacing:	0 to 100 μ sec. Single control	0 to 100 μ sec. Coarse and fine adjustments
Price:	\$498.00	\$645.00

Produce paired or single pulses. Pulse amplitude, width, polarity, repetition rate and pulse-to-pulse spacing are independently adjustable. Outputs may be mixed internally or externally. Model 903 can be driven externally by pulses; Model 4904 by pulses or sine wave generators.

APPLICATIONS

Measurement of paired pulse resolution time of counting circuits. Measurement of rise time, decay time and transient response of pulse forming circuits, electronic switches, gates and wide band amplifiers. Calibration of input sensitivity of counting instruments. Frequency calibration of counting rate meters. Measurements of overload characteristics and dynamic range of pulse amplifiers. Delayed coincidence work.

New EASE* 1100 Series Analog Computers



The 1100 Series introduces a digital output-input translator system (DO/IT) that uses punched tape to set up and check problems, taking much of the human element out of computing and saving hours of operating time. Other new features include automatic static or dynamic problem checking, complete pushbutton monitoring system, and a fully shielded, color-coded patch board. Patch bay capacity 2188 to 3,600 terminals.

A typical setup would include:

- ★ 100 dc amplifiers
- ★ 16 servos
- ★ 300 DO/IT controlled attenuators
- ★ 30 electronic multipliers
- ★ 250 spare terminals
- ★ Required number of trunk lines and terminals for limiters, biases, etc.

Computing resistors are maintained at an accuracy of better than .005% in a temperature controlled oven. Long-term accuracy of capacitors exceeds .05%. New servo-set potentiometer system permits adjustment of 50K Helipot precision potentiometers to an accuracy of better than 0.01% in less than 3 seconds average time.

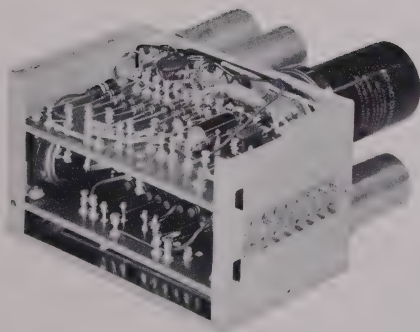
EASE* Precision Components for Control Systems



Model 1191 General Purpose Servo Multiplier

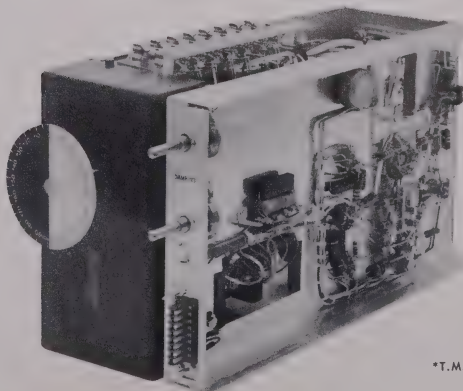
Up to five variables are multiplied by a sixth in the Model 1191 Servo Multiplier. One, two, or three of the five computing potentiometers can be supplied as sine-cosine resolvers. Amplifiers are removeable for ease of maintenance. The front panel contains servo gain and damping controls, as well as servo error light and a shaft position indicator.

No dither is employed, thus minimizing potentiometer wear. Selection of internal or external feedback reference is made through a relay. Servo Multipliers can also be supplied with such special features as a synchro or one extra potentiometer mounted on the potentiometer shaft, additional taps up to 33 total per potentiometer, and various non-linear resolvers.

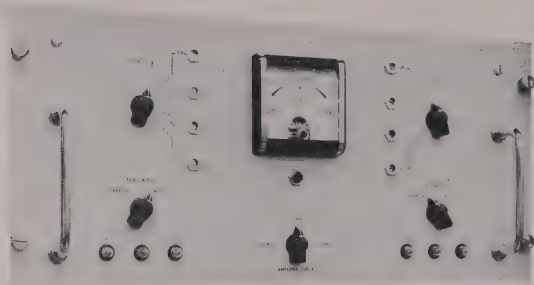


Model 1048B DC Amplifier

This new version of the Model 1048 amplifier, which has become a standard component for industry, features higher out-put current (better than 20 ma) and premium tubes with redesigned circuits for increased tube life.



*T.M.



Model 1157 High Accuracy Electronic Multiplier

Features .02% static accuracy on each of two independent products. Its chopper-stabilized amplifiers are available as inverters and its operation is switched by relay from multiplication to division. Two ranges are available—high accuracy, with a 10KC carrier, and wide band, with a 40KC carrier. This extends the usefulness of the multiplier well beyond the limitations imposed by a single compromise frequency carrier.

Specifications on other 1100 Series components and technical data on the complete computer are available on request. Prices on computer systems may be obtained by writing Sales Manager, Computer, Berkeley Division of Beckman Instruments, Inc., Richmond 3, California.

Customer Services From Beckman/Berkeley

Technical information on all instruments and applications data will gladly be supplied on request. There is no charge or obligation for this service. All literature is prepared by a staff of technical writers who work closely with Berkeley research and applications engineers. Recent literature includes:

Data File 110—FERRISTORS*, Their Use and Application
Data File 111—How to Make Frequency Measurements
Data File 112—How to Make Time Interval Measurements
Data File 10—How to Make WWV Measurements
Data File 123—Analog Computer Solutions for Feedback Control Systems

Beckman/Berkeley Representatives

Berkeley's world-wide staff of factory trained engineering representatives work closely with our sales office and the customer. They help the customer set up newly-purchased equipment, acquaint personnel with its operation and application, and make sure that it stays

in operating order. The representative's job is not completed until he has "followed-up" to insure that the customer receives maximum use from his instruments. These men will be glad to give you personal assistance at any time. A list of Berkeley representatives follows.

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Phone: Union 9-7081

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Phone: Albuquerque 9-4621

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2110 Peachtree St., N.W.
Phone: Trinity 6-300

BINGHAMTON, N. Y.

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Phone: Endicott 5-0296

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Phone: Beacon 2-4804

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Phone: Edison 2-7356

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Ridgeway Engineering Assoc.
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Phone: Tuxedo 9-5715

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Phone: Longacre 1-4567

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Royal Oak, Michigan
Phone: Lincoln 8-4440

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Gene Piety
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Phone: 8-3105

HOUSTON 6, TEXAS

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P.O. Box 6445
(Fairview Station)
Phone: Jackson 6-2959

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Ridgeway Engineering Assoc.
1606 N. Illinois St.
Phone: Walnut 5-6464

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Phone: Jackson 3-9299

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Phone: Dunkirk 7-8224

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Boeing Field, Seattle
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Pinkney & Hine
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Gawler-Knoop Co.
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Phone: Waverly 7-1820

PORTLAND 14, OREGON

Hawthorne Electronics
700 S. E. Hawthorne Blvd.
Phone: Belmont 4-9375

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830 Linden Ave.
Phone: Hillside 5-0460

NEW YORK, NEW YORK

Gawler-Knoop Co.
178 Eagle Rock Ave., Roseland, N. J.
Phone: New Jersey, Caldwell 6-4545

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Phone: Mission 7-1470

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Phone: Dexter 0845

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200 South Main St.
Phone: Elgin 9-1101

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V. T. Rupp Company
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Phone: Cypress 6-0483

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Berkeley Division, Beckman Inst.
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Phone: Landscape 6-7730

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Phone: Mohawk 3962

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Edward A. Ossmann & Associates
308 Merrill Ave.
Phone: Howard 9-3825

TULSA 1, OKLAHOMA

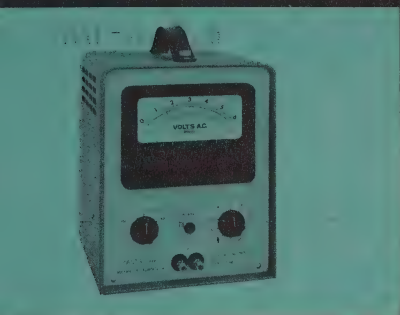
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P.O. Box 911

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8726 Colesville Road,
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WINSTON-SALEM, NO. CAROLINA

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1102 Burke St.
Phone: 4-0750



QUALITY TEST INSTRUMENTS
designed
for the user

Shasta division of Beckman Instruments Inc.
P.O. BOX 296, STATION A, RICHMOND, CALIFORNIA



FEATURES

BRIEF SPECIFICATIONS

Model 100
Synchro Testmeter

± 0.2% ACCURACY
RMS READING
EXPANDED SCALE
READ DIRECTLY IN % DEVIATION
SIMPLE TO OPERATE FOR RAPID
PRODUCTION CHECKS

Accuracy: ± 0.2%
Scale Range: ± 3%
Smallest Division: ± 0.1%
Input Impedance: 10,000 ohms/volt
Input Frequency: 50-2,000 cps
Input Voltage: 57.3, 78, 90, 105, 115
Dimensions: 8" W x 9 3/4" H x 9" D
Price: \$400.00



Model 101
Expanded Scale Voltmeter

± 0.25% ACCURACY
TRUE RMS READING
EASY TO READ EXPANDED SCALE
DIRECT CONNECTION FOR 1 MA RECORDER
ALSO AVAILABLE IN RACK MOUNTED FORM

Accuracy: ± 0.25% of input voltage
Voltage indicated: True rms
Voltage Range: 100-500 (50-250 v for
Model 101-50)
Frequency Range: 50-2,000 cps
Scale Range: 12 v. (6 v for Model 101-50)
Dimensions: 8" W x 9 3/4" H x 9" D
Price: \$360.00 (rack mount — \$400.00)



Model 202A
A.C. Vacuum Tube Voltmeter

EASY-READING 6" METER
WIDE VOLTAGE AND DB RANGE: .001 TO
300 V, —60 TO +50 DB, FULL SCALE
WIDE FREQUENCY RANGE: 20 CPS TO 3 MC
SIMPLIFIED RANGE INDICATOR — SHOWS
ONLY RANGE IN USE

Accuracy: ± 3% full scale to 2 mc,
5% to 3 mc
Meter Ranges: .001 to 100, .003 to 300 (volts.
full scale by factors of 10, calibrated rms
value of sine wave; 12 ranges)
db Range: —60 to +50, 10 db steps
Frequency Range: 20 cps to 3 mc
Input Imp.: 10 meg, 10 mmf
Dimensions: 7 1/4" W x 9 1/4" H x 8 3/4" D
Price: \$190.00

Note: Model 204 VTVM similar to above but
with 2 cps to 300 kc frequency range, \$175.00
Model 207A Log Scale VTVM, similar to Model
202A but with logarithmic scale for uniform
accuracy at any scale point, \$250.00



Model 307A
Wide Range Oscillator

10 CPS TO 1 MEGACYCLE
± 1 DB OVER ENTIRE RANGE
HUM LEVEL LESS THAN 0.1%
DISTORTION LESS THAN 1.0%
DRIFT LESS THAN ± 2 %
INTERNAL IMPEDANCE LESS THAN 55 OHMS
REGULATED POWER SUPPLY

Frequency Range: 10 cps to 1 mc, 5 steps
Amplitude Variation: ± 1 db, 10 cps to 1 mc
Power Output: 160 mw/10 v open circuit/10 v—
600 ohm load
Dial Calibration: Better than ± 2%
Min. Load Imp.: 600 ohms
Hum Level: Less than 0.1% of rated output
Dimensions: 8" W x 9 3/4" H x 9" D
Price: \$165.00



Model 404 Expanded
Scale Frequency Meter

ACCURACY OF ± 1/2 CYCLE
1 MA RECORDER CONNECTION PROVIDED
EXPANDED SCALE FOR EASY,
ERROR-FREE READING
ALSO AVAILABLE IN RACK MOUNTED FORM

Base Frequency: 400 cps
Span: ± 25 cycles
Accuracy: ± 1/2 cycle
Dimensions: 8" W x 9 3/4" H x 9" D
Price: \$330.00 (rack mounted form \$380.00)





FEATURES

10 OHM TO 100 MEGOHM RANGE
SIMPLE PUSHBUTTON OPERATION
HIGH ACCURACY
NEGLECTIBLE DRIFT
GUARD TERMINAL FOR HIGH-RESISTANCE MEASUREMENTS

BRIEF SPECIFICATIONS

Ranges: 100, 1k, 10k and 100k ohms, 1, 10 and 100 megohms
Lowest Meas.: 5 ohms
Accuracy: $\pm$ (0.15% of res. meas., $\pm$.05% full scale)
Drift: Negligible after 30 min. warmup
Dimensions, weight: $9\frac{3}{4}$ "H x 8"W x 9"D; 8 lbs.
Price: \$170.00

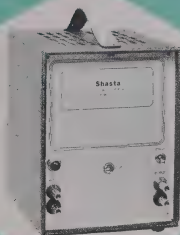
Model 605
Wide Range Resistance Bridge



REGULATION $\frac{1}{4}$ % OR BETTER
RIPPLE LESS THAN 10 MV PEAK TO PEAK
0 TO 400 V OUTPUT @ 200 MA;
CONTINUOUSLY VARIABLE
0 TO -150 V BIAS OUTPUT @ 3 MA
INSULATED + AND - TERMINALS PERMITS
USE OF HIGH VOLTAGE WITH
REFERENCE TO GROUND

Output voltages: 0 to + 400 @ 200 ma
0 to -150 @ 3 ma
6.3 ac @ 8 amp.
Ripple, peak to peak: 10 mv or less
Regulation: Better than $\frac{1}{4}$ %, 0 to full load
Input: 105/130 v, 50-60 cycles
Dimensions: 8"H x 12"W x 10"D
Price: \$205.00

Model 702A
Regulated DC Power Supply



10 X AND 100 X VOLTAGE GAIN
 $\pm \frac{1}{2}$ DB RESPONSE 10 CP5 TO 2 MC @
100 X GAIN, OR 5 CP5 TO 2 MC @
10 X GAIN
LESS THAN 1% DISTORTION
1 MEG, 15 MMF INPUT IMPEDANCE
EQUIVALENT INPUT NOISE, 20 μ V @ 100 X
GAIN, OR 80 μ V 10 X GAIN
ALSO AVAILABLE IN RACK MOUNTED FORM

Input voltage req.: 100 mv rms max @
100 x gain
1 v rms max @
10 x gain
Output: 10 v max into min. of 3000 ohms,
resistive
Power requirements: 105/130 v, 50/60 cps,
67 watts
Dimensions: $9\frac{1}{4}$ "H x $7\frac{1}{4}$ "W x $8\frac{3}{4}$ "D
Price: \$135.00 (rack mounted form - \$150.00)

Model 115A
Wide Band Amplifier



COVERAGE OF ALL WWV AND WWVH
FREQUENCIES
EACH FREQUENCY SELECTABLE BY
FRONT PANEL SWITCH
INDIVIDUAL CRYSTAL FOR EACH FREQUENCY
HIGH SENSITIVITY AND SELECTIVITY
COMPACT, RELIABLE CONSTRUCTION

Frequency Coverage: 2.5, 5, 10, 15, 20 and
25 mc
Sensitivity: Better than 1 μ v for 3 db signal
plus noise-to-noise
Selectivity: 1 kc at 3 db down
Dimensions: 19"W x $5\frac{1}{4}$ "H x $9\frac{5}{16}$ "D;
relay rack mounting
Weight: 17 lbs.
Price: \$495.00

Model 1201A WWV Receiver



ACCURACY OF $\pm 1\%$
0.001 TO 11.11 HENRY RANGE IN
0.001 HENRY STEPS
LIGHT WEIGHT

Range: 0.001 to 11.11 henries,
0.001 henry steps.
Accuracy: $\pm 1\%$
Max. Voltage: 1000 v dc
Dimensions: $12\frac{1}{2}$ "L x $4\frac{1}{8}$ "W x $4\frac{1}{8}$ "D
Weight: $8\frac{1}{2}$ lbs.
Price: \$275.00

Model 1210 Decade Inductor

**SHASTA quality instruments are sold and serviced by representatives
in 24 major cities throughout U.S. and Canada**

SHASTA REPRESENTATIVES

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Baltimore 29, Maryland

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Fort Worth, Texas

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Lee Mark Associates
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Kansas City 14, Missouri

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Phone Dunkirk 7-8224
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Northport Engineering Inc.
186 North Fairview • Phone MI. 4-7884
St. Paul 4, Minnesota

MONTREAL

Electrodesign
736 Notre Dame St. West • Phone UN. 6-7367
Montreal, Quebec, Canada

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Stanley K. Wallace Associates, Inc.
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B. B. Taylor Company
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Rockville Center, New York

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Portland 14, Oregon

ST. LOUIS

Lee Mark Associates
1500 Big Bend Blvd. • Phone Mission 7-1470
St. Louis 17, Missouri

SAN FRANCISCO

G. E. Moxon Sales
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San Mateo, California

SEATTLE

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107 Adm. Bldg., Boeing Field
Phone MO. 3962
Seattle, Washington

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Stanley K. Wallace Associates, Inc.
P.O. Box 744 • Phone Tampa 99-3241
Lutz, Florida

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Electrodesign
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Toronto, Ontario

WASHINGTON, D.C.

S. S. Lee Associates
11107C West Broad St.
Phone JEFFerson 4-3500
Falls Church, Virginia

WINSTON-SALEM

S. S. Lee Associates
P.O. Box 906 • Phone 2-3223
Winston-Salem, North Carolina

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1

Counting, Timing, Frequency Measuring Equipment

EPUT® Meters, Universal EPUT® Meters
 Frequency Meters and accessories
 Time Interval Meters, Preset Counters
 Electronic Counters, Nuclear Scalers
 Decimal Counting Units

2

Recorders, Readouts, Explosion Proof Indicators and Transducers

Digital recorders, Inline-Inplane readouts, explosion proof indicators, light sources, photocells, reflecting tachometers, magnetic tachometers.

3

Special and General Purpose Instrumentation

Expanded scale voltmeters, expanded scale frequency meters, transformation ratio meters, double pulse generators, resistance bridges.

4

EASE* Analog Computers

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Berkeley division of Beckman Instruments, Inc. policy is one of continuous improvement. Therefore, specifications and prices are subject to change without notice. Prices are F.O.B. Richmond, California.

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FUNCTION CHART*

EPUT® METERS

Model	Use	Count Capacity	Count Rate	Time Bases	Binary Coded Output to Drive Digital Printer	Price	Section
5210	Berkeley EPUT® Meters automatically count and display the number of events that occur during a precise time interval. Events may be any physical occurrences that can be represented by changing voltages occurring either regularly or at random rates to 2,000,000 per second.	4 digits	0 cps to 100 KC	0.1 & 1 sec	Optional	\$ 475.00	1-1
7150		5 digits	0 cps to 100 KC	10 μ sec to 1 sec	yes	825.00	1-2
7151		5 digits	0 cps to 100 KC	Time Interval Generator	yes	1195.00	1-4
7160		6 digits	0 cps to 1 mc	1 μ sec to 1 sec	yes	1045.00	1-2
7161	Applications: precision tachometry; measurement of pressure, flow, temperature, viscosity, velocity, frequency, frequency period; process control or data reduction systems; calibration of frequency generating equipment; measurement of any electrical, mechanical, optical or other physical event occurring during a precise time interval.	6 digits	0 cps to 1 mc	Time Interval Generator	yes	1345.00	1-4
7170		7 digits	10 cps to 10 mc	0.1 μ sec to 10 sec	yes	1675.00	1-3
7650		5 digits	0-40,000 cps	0.1 to 10 sec	no	1495.00	1-5

*Not every instrument in the catalog is included here. For a complete listing, please turn to the index at the close of the book.
All prices F.O.B. Richmond, California. Prices and specifications subject to change without notice.

UNIVERSAL EPUT® METERS

Model	Use	Count Capacity	Count Rate	Time Interval	Time Bases	Period	Binary Coded Output to Drive Digital Printer	Price	Section
5230	These truly universal instruments combine high-speed electronic counting with a precision time base in multi-purpose circuitry. They function as counters, timers time-interval meters, EPUT® meters, frequency, frequency ratio or period meters, or as secondary frequency standards.	4 digits	0 cps-100 KC	100 μ sec to 10 ⁴ sec	0.1 & 1 sec	0 cps to 10KC		\$ 575.00	1-6
7350		5 digits	100 KC	10 μ sec to 10 ⁶ sec	10 μ sec to 1 sec	0 cps to 100KC	yes	945.00	1-7
7351		5 digits	100 KC	10 μ sec to 10 ² sec	Time Interval Gener.	0 cps to 10 KC	yes	1295.00	1-9
7360	Applications are: counting, time interval, events-per-unit time measurements for precision tachometry, measurement of pressure, flow, frequency, velocity, viscosity, elasticity; timing relay, shutter action, etc. Measurement of unknown frequencies, frequency ratios, periods, etc.	6 digits	1 mc	1 μ sec to 10 ⁷ sec	1 μ sec to 10 sec	0 cps to 1 mc	yes	1245.00	1-7
7361		6 digits	1 mc	10 μ sec to 10 ³ sec	Time Interval Gener.	0 cps to 10 KC	yes	1445.00	1-9
7370		7 digits	10 cps to 10 mc	0.3 μ sec to 10 ⁷ sec	0.1 μ sec to 10 sec	0 cps to 3 mc	yes	1975.00	1-8

FREQUENCY MEASURING EQUIPMENT

Model	Use	Frequency Range	Characteristics	Price	Section
5571	Frequency meter and Universal EPUT® Meter	0-42 mc	Multipurpose frequency meter and Universal EPUT® Meter. All measurements are displayed in direct digital form.	\$1825.00	1-10
5580	Reference generator to extend Model 5571 to VHF frequency coverage with plug-in units 5581/4-5581/48	For use with Plug-ins from 42 to 515 mc	Basic reference generator that, coupled to proper plug-in unit, generates and multiplies frequencies for direct digital readout of unknown frequency on Model 5571 in VHF range (42-515 mc).	300.00	1-11
5581/4 5581/90	Plug-in units to extend range of 5571 with Reference Generators 5580 and 5582B	42 to 1005 mc	Each Plug-In Unit generates a precise standard reference frequency obtained by multiplication of the one-megacycle crystal oscillator from the Model 5571 Frequency Meter. (An external standard may be used if desired.)	125.00 to 300.00	1-11 1-12
			Basic reference generator that, coupled to the proper plug-in unit, generates and multiplies frequencies for direct digital readout of unknown frequencies on Model 5571 in UHF range (502-1005 mc).	2500.00	1-12
7700	Sensitive frequency measuring system for digital readout over basic communications spectrum.	0.54 to 30.4 mc	Measures carrier frequencies off the air by coupling EPUT® Meter to communications receiver. Sensitivity: .54 to 1.5 mc, 15 microvolts; 1.5 to 30.5 m, 5 microvolts all for 10 db signal to noise ratio sec.	3500.00	1-13
905	Convenient, reliable method of receiving standard time & frequency broadcasts from WWV and WWVH	Fixed band 2.5, 5, 10, 15, 20, and 25 mc	Uses 6 crystals for WWV and WWVH transmissions for 1 microvolt sensitivity. Selectivity approximately ± 1 kc at -3 db without audio filters allowing clear passage of WWV time ticks.	525.00	1-15

TIME INTERVAL METERS

Model	Use	Range	Accuracy	Input Requirements	Count Capacity	Price	Section
5220	Any event delineated by varying voltages may be timed. All models may be standardized against WWV or other external standards. Provisions are also made to measure period of input signals, use as a high speed electronic counter, or frequency ratio meter.	100 μ sec to 1 sec	$\pm 100 \mu$ sec ± 1 part in 10^4	0.25 v rms, 1 megohm dc-coupled	4 digits	\$475.00	1-15
7250		10 μ sec to 1 sec	$\pm 10 \mu$ sec ± 1 part in 10^5	0.1 v rms, 10 megohms ac or dc-coupled	5 digits	695.00	1-16
7260	Applications include: timing of relays, shutters, solenoids, controls; ballistics research; measurement of viscosity, elasticity, velocity; accurate low frequency and period measurements, frequency ratio measurements, etc.	1 μ sec to 1 sec	$\pm 1 \mu$ sec ± 1 part in 10^6	0.1 v rms, 10 megohms ac or dc-coupled	6 digits	925.00	1-16
7270		3 μ sec to 10 sec	$\pm 0.1 \mu$ sec ± 1 part in 10^7	0.2 volts rms, 1 megohm ac or dc-coupled	7 digits	1675.00	1-17

PRESET COUNTERS

Model	Use	Capacity	Input Frequency	Input Sensitivity	Output Information	Price	Section
5422	Counts rates to 40,000 cps, yields output signals at any desired preset total (or any two preset counts with dual preset models). Operates on input pulse of ± 1 volt peak, or more. Instantaneous reset to zero after final count. Reliable, simple to operate. Available in 2, 3, 4, 5, and 6-digit capacities. Long-life magnetic Model 5840 dual preset features FERRISTOR* circuitry for continuous-duty reliability. Typical applications: coil winding, automatic packaging, sorting to length, motor speed control.	1-100	DC to 40 KC	± 1 v. with respect to ground at least 2 microseconds wide. Large amplitudes can be attenuated by front panel potentiometer.	Choice of Pulse, Pulse relay, or hold relay.	\$435.00	1-18
5423		1-1,000				500.00	1-18
5424		1-10,000				595.00	1-18
5425		1-100,000				660.00	1-18
5426		1-1,000,000				740.00	1-18
5442		1-100				650.00	1-19
5443		1-1,000				720.00	1-19
5444		1-10,000				785.00	1-19
5445		1-100,000				845.00	1-19
5446		1-1,000,000				895.00	1-19
5844		1-10,000	DC to 8,000 cps	100 microamperes	For each preset count—45 volt pulse	1115.00	1-20
5845		1-100,000				1205.00	1-20
5846		1-1,000,000				1295.00	1-20

ELECTRONIC COUNTERS

Model	Use	Count Rate	Sensitivity	Binary Coded Output to Drive Digital Printer	Price	Section
5001	For general purpose counting at rates above those of mechanical counters.	0-125 cps	0.5 volts peak	no	\$195.00	1-21
5010		0-10,000 cps	0.5 volts peak	no	330.00	1-21
7050	Gated counter for use as frequency ratio, digital flow computers, slave EPUT® Meter, etc.	0-100 KC	0.1 volts rms	yes	545.00	1-22
7060		0-1 mc	0.1 volts rms	yes	645.00	1-22

RECORDERS, READOUTS, EXPLOSION PROOF INDICATORS

Model	Use	Description	Price	Section
1452	Automatically and permanently records information from any Berkeley 5200 Series, 5510, 5571 or 7000 Series instrument or nuclear scaler.	Prints out data on standard adding machine tape. Printer and scanner in one compact unit. May be modified to print "time" or "code" information simultaneously with data. One print-out every 0.85 seconds.	\$950.00	2-1
5914	Inline-Inplane Readout presents large illuminated figures from Berkeley instruments.	Obtainable in 4, 5, or 6-digit modules. Presents up to 15 readings per second from binary input voltage. All digits readout simultaneously.	610.00	2-2
5915			695.00	2-2
5916			775.00	2-2
1941X	4 and 5 decade readouts housed in explosion proof cases for use in locations where explosive vapors are present.	Primary counting device and explosion proof indicators may be operated literally miles apart.	245.00	2-3
1951X			345.00	2-3

TRANSDUCERS

Model	Use	Range	Description	Price	Section
441	Self contained reflecting photocells and light sources designed for use where alternate reflecting and non-reflecting surfaces are available, such as a metal disc with a black rule.	100 to 20,000 light pulses per second	Generates 1.5 volt output signal at working range of 2 inches	\$135.00	2-5
443		0 to 10,000 light pulses per second	Generates 4.0 volt output signal at working distance of 1½ inches. Housed in two separate units. DC level adjustment may be made near the counter.	195.00	2-5
453	For use where pulses are generated by interrupting a light beam. Both models use Model 454 light source.	0 to 10,000 light pulses per second	Both models will operate at distance of 3 inches to 6 feet. Model 453 presents 1.0 volt output signal; Model 458, 35 volt fast rising pulse. Model 458 especially useful where minute increases of time are under measure.	85.00	2-4
458		0-100,000 light pulses per second		90.00	2-4
461	Tachometer transducers to generate pulses accumulated by Berkeley counters in rotational speed measurement.	200-7500 rpm	See specifications.	150.00	2-6
465		25-7500 rpm		290.00	2-6
466		25-10,000 rpm		290.00	2-6
467		0-3,000 rpm		150.00	2-6

SPECIAL AND GENERAL PURPOSE INSTRUMENTATION

Model	Title	Description	Price	Section
101 & 101-50	Expanded Scale Voltmeters	An invaluable tool for all types of testing where high accuracy is a requisite; for example, production, quality control of components, measuring voltages in a-c power systems, etc. High voltages may be read to $\pm 0.25\%$ of input voltage. Model 101 reads from 100 to 500 volts in 10 volt steps; Model 101-50, 50 to 250 volts in 5 volt steps.	\$360.00	3-1
115	Portable Expanded Scale Voltmeter	Lightweight instrument for measurement of line voltages in remote locations where accuracies of ± 0.7 volt in the 100-130 volt range are desired. Frequency range, 50-2,000 cps.	105.00	3-2
404	Expanded Scale Frequency Meter	For fast monitoring of frequencies over the range 375-425 cps. to an accuracy of ± 0.5 cps.	330.00	3-3
100	Transformation Ratio Meter	An rms reading expanded scale voltmeter designed to compare primary and secondary voltages of synchros faster and easier than by conventional methods. Accuracy $\pm 0.2\%$ for input voltages of 57.3, 78.0, 90.0, 105.0, or 115.0.	400.00	3-4
605	Wide Range Resistance Bridge	A convenient instrument for quickly checking resistances to a high degree of accuracy, 100 ohm to 100 megohm range in seven ranges. Accuracy $\pm (0.15\% \text{ of resistance under measure} + .05 \text{ full scale})$.	170.00	3-5
903 & 4904	Double Pulse Generators	General purpose laboratory instruments that provide a source of clean paired or single pulses. Pulse width, amplitude, spacing polarity and repetition rate may be independently adjusted.	495.00	3-6
			645.00	3-6



Beckman/Berkeley, now in its second decade, supplies industry and science throughout the world with more than two hundred types of electronic counting, control and computing equipment.

An organization of highly skilled and experienced engineers, designers and production workers, Berkeley is equipped to mass produce a wide range of instruments for science, industry and technology. Techniques for the mass production and assembly of high speed counters, timers and frequency measuring equipment originated at Berkeley. A recent factory expansion program has more than doubled production capacity and places the company in an excellent position to keep pace with the tremendous growth of the electronics industry. Beckman/Berkeley's factory in Richmond, California, occupies 105,000 feet of floor space and employs more than 700 men and women.

Facilities are by no means limited to quantity production of standard type instruments. The Engineering Department conducts research development and product design operations in four major fields of electronic interest—counting, timing, and frequency measuring equipment, analog computers, nuclear test instruments and special products. A recent, significant result of this program was the development of the Ferristor*, a miniature magnetic amplifier that will replace nearly all the vacuum tubes used in conventional counting and timing equipment.

Naturally this stress on research and development has resulted in important electronic "firsts" at Berkeley. Some of these include:

The first console style push-button analog computer (EASE)*

The first direct reading time interval meter for counting up to a million events per second

The Ferristor, miniature vacuum tube replacement*

The original electronic decade unit (DCU)

The first 1,000,000 count per second events-per-unit-time meter (EPUT)*

A direct reading frequency meter

The digital recorder with printer readout

The first in-line, in-plane digital indicator.

Despite the emphasis on research and production, as much importance has been attached to quality. Standard inspection procedures are not sufficient at Berkeley. Statistical quality control has been instituted as part of the regular inspection procedures. This has resulted in effective preventive techniques rather than the usual type of corrective inspection methods.

Beckman/Berkeley, of course, does not stand alone in its efforts to maintain a leading position in the industry. Since 1952, Berkeley has been a division of Beckman Instruments, Inc., itself a leader in the electronics field. Backed by Beckman, Berkeley Division has been able to expand its facilities whenever needed. With this support, Berkeley is now equipped, and will remain equipped, to design and develop almost any type of electronic instrument and produce it in quantity.

Research, Development and Product Engineering

Our engineering department maintains a continuous program to improve existing products, research new materials, and develop new instruments to accelerate the nation's technological progress. Beckman/Berkeley engineers have proved themselves competent to solve a wide variety of problems. Their basic areas of experience are in frequency and time measurement, conversion of physical phenomena to digital

form, digital information handling, analog computation and control, nuclear instrumentation, visual and printed display devices, and development of both special and general purpose electronic instruments.

The engineering department is efficiently organized on a "project" basis with supporting staff functions. Product Engineering is among the most important of these functions. Only the most experienced and skilled specialists have been employed for prototype layout and construction, product design drafting, components engineering, methods and procedure engineering, and technical writing, Beckman/Berkeley engineers have been provided with every facility needed for the development of high quality instruments. For example, engineering has a complete laboratory of test equipment, one of the finest installations of its kind anywhere. This equipment has proved invaluable in the construction and design of new instruments. The engineering department also has available a model shop and an analog computer facility for solving design problems.

Neither does Beckman/Berkeley have any shortage of engineering talent. The Technical Director has the services of 150 engineers and supporting technicians, many of whom have advanced engineering degrees.

Computer Engineering

The Beckman/EASE* computer manufactured by Beckman/Berkeley and introduced in 1952, has found ready acceptance in a great variety of industrial and scientific research centers. Installations vary in complexity from two or three racks of equipment at small universities to 29 racks at Allison Division of General Motors' huge jet engine research center at Indianapolis, Indiana. One of the first electronic analog computers on the market, EASE* maintains a commanding position in the industry as the result of constant efforts to improve the computer, broaden its application, and provide more computing time per dollar.

Recent introduction of the EASE* 1100 computer with digital output input translation has opened up a new realm for the analog computer.

The catalog of EASE* equipment includes a variety of operational amplifiers, manual and automatic function generators, electronic multipliers, servo multipliers and resolvers, and a complete assortment of accessories to build a computer installation to exact customer requirements.

Manufacturing

Our manufacturing facilities are adaptable to both job order lots and production runs. Assembly, Fabrication and Inspection Departments are keyed for integrated operation. Production planning is thorough from tooling through processing to insure quality work. Each year, a large percentage of profits are used to purchase new equipment.

Every facility designed to expedite the production of instruments has been provided. For example, our Fabrication Department is equipped with a 100-ton hydraulic press brake and drawing press, a ten-foot micrometer operated shears, and a complete aluminum and steel welding section in addition to the usual tools and machinery.

The Assembly Department is equipped to produce both standard instruments and those requiring special modifications for the customer. This department performs silk screening, riveting, cable lacing, wire striping, sub-assembly, chassis assembly,

panel fill and assembly, decimal counting unit assembly, and final assembly operations. More than 150,000 decimal counting units have been built by the Assembly Department during the past seven years.

All Beckman/Berkeley equipment is aged 40 hours and subjected to both visual and electrical inspection before it reaches the customer. The Inspection Department uses statistical quality control procedures to insure the production of trouble-free instruments. Statistics from each phase of inspection—from parts receiving to final electrical—are plotted on control charts. This gives a continuous picture of the quality level and permits rapid correction of any defects. Fabrication and Assembly operations are in-process controlled to provide a step-by-step check of the production run. By using these methods, Beckman/Berkeley is able to build quality into its instruments rather than inspecting it into them.

The People

Axiomatically, the quality of product depends upon the people who design and produce it. Throughout its growth, Beckman/Berkeley has sought out the best talent, carefully compiling a first rate staff of scientists and engineers, technicians and production workers. Beckman/Berkeley credits a large measure of its success to the personnel whose ingenuity and competence keep the company continually in the forefront of the electronics industry.

Constant planning and review characterize Beckman/Berkeley's research, development and product design program. A committee representing management plus the engineering and sales departments meets monthly to determine future projects and to review current progress. The Technical Director executes the plans decided upon, drawing on the talents of his own staff as well as the services of outstanding engineering consultants to keep him advised of newest engineering and production techniques.

The Location

Visitors are always welcome at our modern plant situated slightly north of the University of California on the shores of San Francisco Bay.

*T.M.

Ordering from **Beckman** *Berkeley*

Order by Model Number and Title

Please order by Model number and title. For example, an order for a one megacycle Universal EPUT® meter with a 4 digit mechanical register to extend its counting capacity by 10^4 counts, (modification C) should read: "Model 7360C Universal EPUT® meter." Variations in color and other non-standard modifications should also be noted.

Where to send the order

Orders may be sent directly to Beckman/Berkeley Division, 2200 Wright Avenue, Richmond 3, California, or address to Beckman/Berkeley Division in care of the nearest engineering representative whose names and addresses appear inside the back cover. All orders are subject to final acceptance by the factory.

Engineering Representatives

Technical sales representatives are located throughout the United States, Hawaii, and Canada. Foreign sales are handled by Beckman's International Sales Division with head offices located in Fullerton, California. Any of our representatives will be happy to assist you. These highly qualified engineers can supply full information and contribute to the solution of your problems.

Shipments

Instruments are shipped by the best way commensurate with the customer's requirements. For short distances, motor freight, parcel post, or railway express are used. East Coast shipments are usually sent air freight. Naturally, shipments will be sent any way the customer prefers.

Repairs

Instruments returned for repairs should be sent prepaid to the Customer Service Department, Beckman/Berkeley Division, 2200 Wright Avenue, Richmond, California. Please give us the name, model, serial, and lot numbers. If you have a schematic diagram noting any changes or modifications, please pack it with the instrument. Any information concerning the failure will help us give you speedy service.

Usually, repairs can be made by our engineering representatives. Their offices are listed inside the back cover.

Repairs are made by Beckman/Berkeley on a time and materials basis. To get maximum service from Beckman/Berkeley instruments, you are invited to make use of this service.

Parts

Replacement parts should be ordered by Beckman/Berkeley stock number, reference to schematic diagram part number, and name, serial, and lot number of the instrument where known. Order with care to assure satisfaction.

Contact

Factory — Mail: Beckman/Berkeley Division, A Division of
Beckman Instruments, Inc.
2200 Wright Avenue, Richmond, California
Telephone: LAndscape 6-7730
TWX: Richmond 433

Engineering Representatives — Beckman/Berkeley engineering representatives may be contacted at any of the offices listed inside the back cover.



COUNTING, TIMING, and FREQUENCY MEASURING INSTRUMENTS

MODELS 5210, 7150, 7151, 7160, 7161, 7170, 7650 EPUT® METERS

MODELS 5230, 7350, 7351, 7360, 7361, 7370 UNIVERSAL EPUT® METERS

**MODEL 5571 FREQUENCY METER, MODELS 5580 AND 5582 REFERENCE GENERATORS,
MODELS 5581/4 THROUGH 5581/90 PLUG-IN-UNITS, MODEL 7700 SENSITIVE FREQUENCY
MEASURING SYSTEM, & MODEL 905 WWV RECEIVER**

MODELS 5220, 7250, 7260, & 7270 TIME INTERVAL METERS

SERIES 5420, 5440, & 5800 PRESET COUNTERS

MODELS 5001, 5010, 7050, & 7060 ELECTRONIC COUNTERS

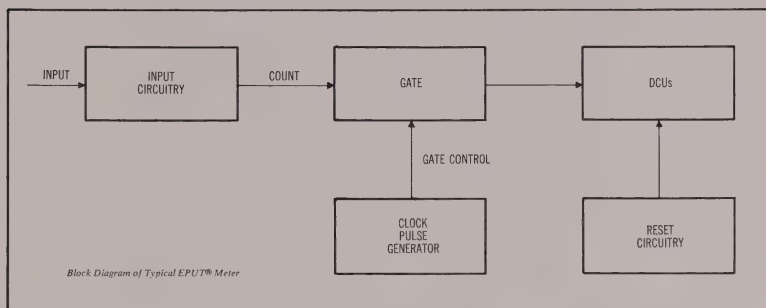
MODEL 2025 NUCLEAR SCALER

MODELS 705A, 706A, 707A, 716, 717, 730A, 732 & 736 DECIMAL COUNTING UNITS

Berkeley Events-Per-Unit-Time (EPUT®) Meters are high speed electronic counters with built-in time bases to extend their versatility.

The time base produces accurate signals for timing the counting period. This allows the EPUT® Meter to be used as a timed sampling device suitable for electronic tachometer, flow measurements and many other applications.

Berkeley offers a wide variety of EPUT® Meters. The block diagram illustrates a typical meter. Input circuitry receives and shapes the incoming signal and applies it to the gate.



The clock signal opens the gate for a preselected time and during this time counts accumulate on the DCUs. After a variable display period, the instrument will automatically reset or may be reset manually at any time at the discretion of the operator.

Beckman/Berkeley EPUT® Meters also perform several other functions. For example, a Scan function is usually incorporated to allow frequency measurements over a manually controlled sampling time with no loss of accuracy. Period function is usually included to permit more accurate measurement of low frequencies. The Count function is retained so that the EPUT® Meter may be used as a straight electronic counter.

Most Berkeley EPUT® Meters have a four line binary-coded readout available for operating a Berkeley digital recorder or in-line readout.

EPUT® Meters find further application in calibrating and checking the stability of frequency generating equipment, making flow and pressure measurements.

Berkeley offers a Magnetic EPUT® Meter employing Ferristor* saturable reactors which perform most of the functions of electron tubes — input amplifier, gate, time base, DCUs and control circuits. These reactors are not affected by high temperatures found in many industrial installations. They consist of a simple, wire-wound coil on a ferro-magnetic core and are non-aging, immune to shock damage, vibration, moisture and accidental overloading.

The Magnetic EPUT® Meter consists of an input amplifier, a gate which is opened and closed by a tuning-fork controlled time base, and a series of magnetic DCUs. Function performed is indicated in the block diagram for electron tube EPUT® Meters.

The input amplifier is a sensing device that will respond to currents as small as ± 3 milliamperes. This characteristic is basically different from electron tube input amplifiers which are voltage sensing devices.

A typical application consists of a Berkeley EPUT® Meter used with a Berkeley Magnetic Tachometer Transducer for measuring the speed of a shaft. The transducer is equipped with 60 teeth and the EPUT® Meter set for a one second sample. Readout is directly in rpm. For more complex measurements a selectable time base instrument is recommended. A selectable time base permits direct readings in gallons per minute, pounds per hour, and other units of measurement.

*T.M.

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MODEL 5210 PORTABLE EPUT® METER



FEATURES

- Printed Circuits
- Compact Design-Portable
- Scan Function
- Simplified Controls
- Ease of Servicing
- High Quality at Moderate Cost

The Model 5210 EPUT® Meter combines many features usually found at a higher price, with low cost, lightweight, and portability.

The Model 5210 counts events electronically at high speed for an interval of time determined by the frequency standard employed. The Model 5210 uses 60 cycle line frequency for a timing standard. Internal crystal controlled timing standard available at extra cost.

A function switch permits the operator to select the desired function. The input channel, time base, gate and DCU's are corrected in various ways through the function switch for use as a straight timer, E/UT or Period Meter, or Scan. A Test function is also provided so the operator

may easily check the operation of the time base and DCU's. The input channel is provided with a trigger level adjustment and a slope selector switch. Use of a trigger level control rather than a gain control permits accurate measurement of complex wave forms and provides discrimination against noise signals.

In the Count function the instrument behaves as a straight electronic counter, totalizing events.

In the E/UT function, the components are so arranged that the input signal is counted for an interval of time determined by the timing standard. This function is useful in electronic tachometry, and other applications yielding relatively large count indications for a sampling period of one second or less.

If the accumulated count is small, the accuracy and convenience of measurement may be increased by using the Period function where internally generated timing pulses are counted for a time determined by the period of the externally applied signal.

The Scan function allows the E/UT function to be extended for any multiple of 1 second. This brings an increase in the accumulated count by manually extending the sampling time.

Some of the applications of EPUT® Meters are electronic tachometry, pressure measurements and other applications requiring accurate, high speed measurements. Data Files 111 and 112 have been prepared to acquaint you with the many applications of these versatile instruments. Copies may be had free of charge through your Berkeley representative or on written request to the factory.

SPECIFICATIONS	Model 5210
Functions	E/UT, Period, Scan, Count, Test
Range	
Frequency	0 cps—100 kc
Period	0-10 cps
Count Capacity	Readout four digits
Time Bases	0.1 and 1 second, Ext.
Accuracy	± 1 count $\pm$ deviation of 60 cycle line (1 part 10^3 average stability)
External Standard Input	100 cps to 100 kc, 3 volts rms
Sensitivity	0.25 volt rms
Input Impedance	1 megohm, direct
Trigger slope	Positive or negative
Input Circuit Control	Trigger voltage adjustment with a range of ± 5 volts
Test	Check all frequency dividers and counters
Display Time	Adjustable 0.05 to 5 seconds when on automatic reset, indefinite when on manual reset
Auxiliary Connections	
Frequency Jack	For introducing external timing standard
Power Requirements	105, 117 or 126 volts $\pm 10\%$, 50-60 cps 115 watts. (Supplied wired for 117 v.)
Dimensions	12" H, x 8" W, x 14" D
Shipping Weight	30 lbs. approx.
Price	\$475.00, F.O.B. Richmond, California

MODIFICATIONS

Modification B ₁	Incorporates additional circuitry to extend time base to 10 seconds. Price: \$70.00
Modification E	Extinguishes DCU's during scaling. Price: \$65.00
Modification H	Standard transformer replaced by unit having two tapped primary windings allowing operation from 210, 222, or 231 volts $\pm 10\%$ in addition to the 105, 117, or 126 volt $\pm 10\%$ operation normally supplied. Frequency 50-60 cycles. Supplied wired for 222 volt $\pm 10\%$ operation with proper line fuses. Price: \$25.00
Modification P	Provides binary coded readout for driving Digital Recorder or Inline Readout. Price: \$30.00



FEATURES

- TEN MEGOHM INPUT IMPEDANCE, Direct or AC Coupled
- BINARY-CODED OUTPUT Information from all DCUs
- OUTPUT PULSES from Time Base for Use as Secondary Frequency Standard
- DIGITAL FREQUENCY MEASUREMENTS

Berkeley Models 7150 and 7160 EPUT® Meters are electronic counters designed to count events at high speed for a precise interval of time. They consist of an input channel, gate and a series of DCU's. Input channels are provided with step-attenuators in addition to trigger level controls. Use of trigger level controls rather than gain controls permits accurate measurement of complex waveforms and provides discrimination against noise signals. A highly stable crystal controlled oscillator, followed by an exact divider chain, provides precise timing signals for controlling the gate. Measurements are displayed in direct digital form.

The function switch permits the operator to select the desired function. In addition to Events-Per-Unit-Time (E/UT), Scan, Count, Period, and Test functions are available.

In E/UT function, the various component units are interconnected so that the signal is counted for a precise time interval. This function is useful for making high frequency measurements, in electronic tachometry and other applications where the count accumulated during one second or less is appreciable.

If the accumulated count is small, the accuracy and convenience of measurement may be increased by using the Period function where internally generated timing pulses are counted for a time determined by the period of the externally applied signal.

In Count the instrument functions as a straight electronic counter, totalizing events applied to it.

In Scan the E/UT function may be extended for any multiple of 1 second. This provides an increase in the accumulated count by manually extending the sampling time.

Binary-coded output is available on a 40-pin connector on the rear of the instrument. This information will operate Berkeley Digital Recorders and Inline Readouts.

Some of the applications of EPUT® Meters are:

- Electronic Tachometry
- Calibrating of Frequency Generating Equipment
- Frequency Stability Measurements
- Testing of Quartz Crystals
- Secondary Frequency Standard
- Standard Timing Generator for Telemetry
- Pressure Measurements
- Flow Measurements
- Laboratory Frequency Measurements

Data Files 111 and 112 have been prepared to acquaint the reader with many interesting and unique applications of these versatile instruments. Copies may be obtained from your Berkeley engineering representative or on written request to the factory.

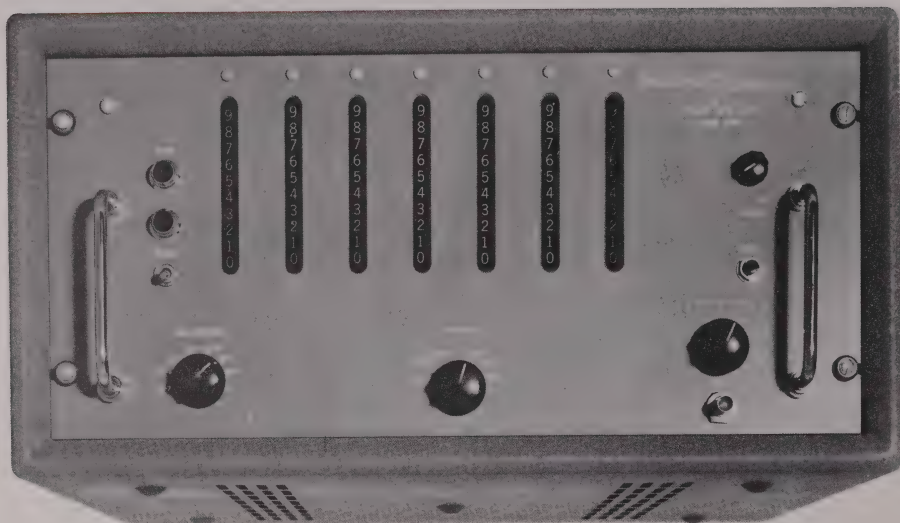
SPECIFICATIONS	Model 7150	Model 7160
Functions	E/UT, Period, Scan, Count, Test	
Count Capacity	Readout 5 digits	Readout 6 digits
Range (Sine wave or pulse) Frequency Period	0 cps to 100 kc 10 μ sec. to 10 ⁵ seconds	0 cps to 1 MC 1 μ sec. to 10 ⁶ seconds
Time Bases	10 μ sec to 1 sec, decade steps or external frequency (0-100 kc) or (frequency only) any multiple of 1 sec (or 10 sec with Modification B)	1 μ sec to 1 sec, decade steps or external frequency (0-1 MC) or (frequency only) any multiple of 1 sec (or 10 sec with Modification B)
Accuracy	± 1 count ± 1 part in 10 ⁵	± 1 count ± 3 parts in 10 ⁷ per week
External Standard Input	0-100 kc, 3 volts rms	0-1 MC, 3 volts rms
Output Frequencies	1 cps to 100 kc, decade steps	1 cps to 1 MC, decade steps
Sensitivity (frequency or period)	0.1 volt, rms	
Input Impedance	10 megohms, direct or a-c coupled	
Trigger Slope	Positive or negative	
Input Circuit	Step attenuator with trigger level adjustment ranges of ± 1 , ± 10 , and ± 100 volts	
Test	Check of all frequency dividers and counters	
Standardization	May be standardized against WWV or other external frequencies	
Display Time	Adjustable 0.1 to 10 seconds (automatic electronic reset) Display can be held indefinitely (manual reset)	
Printer Connection	Binary coded output information from DCU's to operate Model 1452 Digital Printer or Series 1440 Data Converters or inline readout accessories.	
Power Requirements	105, 117 or 126 volts, $\pm 10\%$, 50-60 cps, (supplied wired for 117 v.) Model 7150, 220 watts, 7160, 300 watts	
Dimensions	Cabinet Mount: 10½" H x 20¾" W x 16½" D Rack Mount: 8¾" H x 19" W x 16" D	
Shipping Weight	Approximately 60 lbs.	
Price	Model 7150: \$825.00, Model 7160: \$1045.00, F.O.B. Richmond, California	

MODIFICATIONS:

Modification B	Provides an additional time base of 10 seconds and averages period measurements over 10 periods. Increases the count capacity by a factor of 10. Adds additional DCU to readout display. Price: \$70.00
Modification C	Adds 4-digit mechanical register. Extends capacity by 10 ⁴ counts when not combined with Modification B. Price \$80.00
Modification D (7150)	Adds temperature controlled crystal for greater stability. Crystal stability is ± 3 points in 10 ⁶ per week. (Standard on Model 7160). Price: \$30.00
Modification E	Extinguishes DCU's during scaling. Price: \$65.00
Modification F	Combined modifications B, D, and R plus panel mounted input sensitivity meter. Price: \$140.00
Modification G (7150)	For automatic time base scanning. Automatic operation obtained by the addition of a preset timer. Permits selection of precise time bases from 3 to 60 seconds. Operation, including recycling, is completely automatic. Price: \$130.00
Modification H	Standard transformer replaced by unit having two tapped primary windings allowing operation from 210, 222, or 231 volts $\pm 10\%$ in addition to the 105, 117 or 126 volt $\pm 10\%$ operation normally supplied. Frequency 50-60 cycles. Supplied wired for 222 volt $\pm 10\%$ operation with proper line fuses. NOTE: Crystal oven is rewired to operate only when Power Switch is ON. Price: \$25.00
Modification J (7160)	Provides 2 mc B channel and higher frequency DCU's (711AH and 713AH instead of 707AH and 705AH) to extend upper range to 2 mc. Price: \$80.00
Modification K	Increases input sensitivity from 0.1 volts to 5 millivolts at 5 cps providing operation from flow meter transducers. Price: \$50.00
Modification R	Standard relay rack mounting (3¾" x 19" panel). Substitutes a protective cover in place of the cabinet. No extra charge on original order
Modification T (7150)	Combines modification V (drive circuit for remote indicator), and changing one second time base to 0.5 seconds. Commonly used as electronic tachometer in installations using a 120-tooth magnetic tachometer pickup. Price: \$85.00
Modification V (7150)	A drive circuit to operate Models 1941X or 1951X explosion-proof remote indicators. Price: \$50.00

1 - 3

MODEL 7170 EPUT® METER



FEATURES

- FREQUENCY MEASUREMENTS TO 10 mc
- SEVEN DIGIT Readout
- ACCURATE CLOCK SIGNALS Available for External Use
- BINARY-CODED OUTPUT Information from All DCUs

The Beckman/Berkeley Model 7170 EPUT® Meter has been developed for applications requiring an instrument capable of measuring frequencies above the range of conventional EPUT® Meters. This instrument will measure frequencies from 20 cps to 10 mc and read to seven digits.

The major components of the Model 7170 are arranged in much the same way as in other Berkeley EPUT® Meters. Special high speed circuitry is used to gain increased operating speed.

The input channel is equipped with a step attenuator that prevents overdriving. The time base consists of a

1 mc, oven stabilized, crystal controlled oscillator and a series of precise electronic frequency dividers. Seven DCU's are employed for a maximum readout of 9,999,999. Binary-coded output information is available from all the DCU's on a connector at the rear of the instrument, and may be used for driving the Berkeley digital recorders and in-line readouts.

A partial list of applications includes:

- Calibration of frequency generating equipment
- Frequency Stability measurements
- Monitoring
- Crystal testing
- Secondary frequency standard
- Flow measurements
- Pressure measurements

SPECIFICATIONS	Model 7170
Functions	E/UT Count, Scan E/UT x 10, Test
Count Capacity	7 digit
Range	10 cps — 10 mc
Time Base	1 μ sec to 10 sec.
Accuracy	± 1 count $\pm$ oscillator stability
Oscillator Stability	± 3 parts in 10^7 per week
Output Frequencies	1 cps to 10 mc
External Standard Input	0-1 mc, 3 volt rms
Sensitivity	0.1 volt rms
Input Impedance	1 megohm, a-c coupled
Input Circuit Controls	Step-attenuator
Self Test Facility	Check of all frequency dividers and decimal unit counters
Standardization	May be standardized against WWV or other external frequencies
Display Time	Adjustable from 0.1 to 10 seconds when on automatic reset, indefinite when on manual reset.
Auxiliary Connections:	Binary coded information from the DCUs to operate a printer or other accessories
Frequency Jack	For outside utilization of the internal frequency or introducing an external frequency
Time Jack	Accurately spaced pulses are available for external use as clock signals.
External Reset	Permits reset by shorting two pins of connector
Power Requirements	105, 117, or 126 volts $\pm 10\%$, 50/60 cps, 300 watts approximately. (Supplied wired for 117 v.)
Dimensions	10 $\frac{1}{4}$ " H x 20 $\frac{3}{4}$ " W x 16 $\frac{1}{2}$ " D
Shipping Weight	60 lbs. approximately
Price	\$1675.00, F.O.B. Richmond, California

MODIFICATIONS:

Modification C	Adds 4 digit mechanical register and associated drive circuit. Price: \$80.00
Modification H	Standard transformer replaced by unit having two tapped primary windings allowing operation from 210, 222, or 231 volts $\pm 10\%$ in addition to the 105, 117, or 126 volt $\pm 10\%$ operation normally supplied. Frequency 50/60 cycles. Supplied wired for 22 volt $\pm 10\%$ operation with proper line fuses. NOTE: Crystal oven is rewired to operate only when Power Switch is ON. Price \$25.00
Modification R	Provides for relay rack mounting. No charge on original order.



FEATURES

- **PRESET TIME BASE**—for direct digital indications of flow, speed pressure, etc. without conversion.
- **TOTALIZE**—for indicating the sum of groups which are pre-selected and counted by the instrument.
- **PERIOD MEASUREMENT**—with range selection of 1 to 9,999 cycles of the unknown.
- **BINARY CODED Output**—for operating a digital recorder, inline readout, or data reduction systems.
- **UNUSUAL FLEXIBILITY**—also operates as a frequency divider, a single preset counter, and pulse generator of varying frequencies.

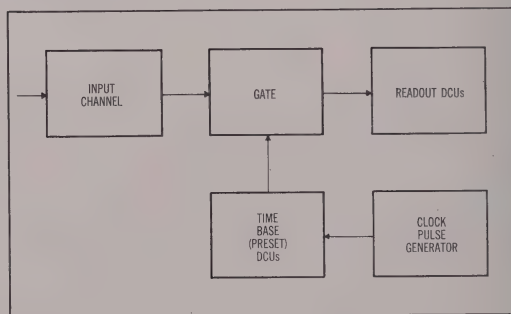
Beckman/Berkeley Models 7151 and 7161 Preset EPUT® Meters incorporate four preset DCU's in their time base. The use of a preset time base results in rapid self computing measurements in addition to functions usually attributed only to combinations of instruments such as an events-per-unit-time meter combined with a preset counter. One of the principal fields of use for instruments of this type is flow meter work. However, the flexible design offers a number of operating modes for other applications.

Models 7151 and 7161 have flexible input circuitry that may be ac or direct coupled and use a step attenuator with trigger level control to permit measurement of complex wave forms and provide discrimination against noise signals.

Owing to the functional layout of the operating controls, operation is simple and convenient. Modular chassis construction is used throughout. A self-testing function is provided to verify the operation of the preset and readout DCU's.

The clock-pulse generator consists of a 100 kc over stabilized crystal controlled oscillator and a frequency divider chain consisting of an electronic divider and four

preset DCUs. The Function switch lets the operator easily arrange the components*. Functions available include E/UT, Period, Time-Interval-Generator, Totalize, Scan and Test. The functions provide a means for measuring frequency in addition to operation as a preset counter and electronic counter. The simplified block diagram will serve to illustrate the principal circuits incorporated in these instruments.



To use the instrument, all that is required is to select the desired function and introduce electrical signals within the sensitivity and frequency range of the instrument. Appropriate transducers produce electrical signals of varying frequency to represent physical phenomena. The preset time base permits the instrument to be "calibrated" for a particular operation so that measurements are in units of gallons per minute, revolutions per minute, or in whatever other units are desired.

The preset DCUs lend increased flexibility for "conventional" EPUT® Meter measurements and enable these instruments to perform as preset counters and time interval generators. In either of these functions the preset time

base produces an output whenever the preset number is reached. In the Totalize function, an external signal is fed to the preset DCUs and their output accumulated on the readout DCUs. This eliminates the need for a separate preset counter.

High accuracy and rugged construction make these instruments the logical choice for industrial as well as laboratory installations. The "computing" feature of the preset time base ideally equips these instruments for flow measurements and other applications where several variables are encountered. Modification "K" increases the sensitivity of these instruments for flow measurements involving low rates or reduced transducer output.

A partial list of applications includes:

FREQUENCY

Flow Measurement and other rates
Tachometry
Frequency Measurement
Phase Measurement

Secondary Frequency Standard
Viscosity
Pressure

Data File 111 "How to Make Frequency Measurements" and Data File 112 "How to Make Time Interval Measurements" have been prepared to acquaint you with some of the unique and interesting applications of these models. They are available for the asking from Berkeley representatives or from the factory.

SPECIFICATIONS	Model 7151	Model 7161
Functions	E/UT, Period, Time-Interval-Generator, Totalize, Scan, Test	
Count Capacity	Readout 5 digits	Readout 6 digits
Range:		
Frequency	0 — 100 kc	0 — 1 mc
Period	1 to 9,999 periods of inputs from 0 cps to 10 kc	
Time Interval Generator	0.1 to 9,999 milliseconds	
Totalize	Divides frequencies between 0 and 10 kc by any number from 1 to 9,999	
Time Bases:		
E/UT and TIG	Variable in 0.1 millisecond increments from 0.1 millisecond to .9999 seconds and in 1 millisecond increments from 1 millisecond to 9.999 seconds	
Period	10, 100, and 1000 μ seconds	
Frequency Jack	For outside utilization of the internal frequency or introducing an external frequency	
Time Jack	Output of Preset DCUs	
Accuracy	± 1 count $\pm$ oscillator stability	
Oscillator Stability (100 kc)	± 1 part in 10^4 per day	
External Standard Input	0 to 100 kc, 3 volts rms	
Sensitivity (all functions)	0.1 volt rms	
Input Impedance	10 megohm, direct or ac coupled	
Trigger Slopes	Positive or Negative	
Input Circuit Controls	Step attenuators and trigger voltage adjustments having ranges of ± 1 , ± 10 and ± 100 volts	
Self Test Facility	Check of all frequency dividers and decimal unit counters	
Standardization	May be standardized against WWV or other external frequencies	
Display Time	Adjustable from 0.1 to 10 seconds when on automatic reset, indefinite when on manual reset	
Other Features:	4 DCUs used to give the variable time base for E/UT and to extend range of PER	
Power Requirements	105, 117, or 126 volts $\pm 10\%$, 50/60 cps (supplied wired for 117 v) 300 watts (approximately)	
Dimensions	Cabinet Mount 10 $\frac{1}{4}$ " H x 20 $\frac{3}{4}$ " W x 16 $\frac{1}{2}$ " D Rack Mount 8 $\frac{3}{4}$ " H x 19" W x 16" D	
Weight	50 pounds (approximately)	
Price	Model 7151: \$1195.00, Model 7161: \$1345.00, F.O.B. Richmond, California	

MODIFICATIONS:

Modification B (7151)

Adds a fifth preset DCU (Not available on 7161, or with modification "C"). Price: \$70.00

Modification C

Adds a 4 digit mechanical register. Price: \$80.00

Modification E

DCUs extinguished during scaling period. Price: \$65.00

Modification H

Standard transformer replaced by unit having two tapped primary windings allowing operation from 210, 222, or 231 volts $\pm 10\%$ in addition to the 105, 117, or 126 volt $\pm 10\%$ operation normally supplied. Frequency 50-60 cycles. Supplied, wired for 222 volt $\pm 10\%$ operation with proper line fuses. NOTE: Crystal oven is rewired to operate only when Power Switch is ON. Price: \$25.00

Modification K

Input sensitivity 5 millivolts at 5 cps permitting operation from flow meter transducers. Price: \$50.00

Modification L

Provides remote preset feature. Price: \$50.00

Modification R

Rack Mounting. No charge on original order.

Modification V (7151)

Provides drive circuit for driving Remote Indicator Models 1941X and 1951X. Price \$50.00

1 - 5

MAGNETIC EPUT® METERS 7600 SERIES



SPECIFICATIONS	Model 7650 Magnetic-Events-Per-Unit Time Meter
Counting Rate	0 to 40,000 per second
Count Capacity	99,999
Accuracy	± 1 count plus time base accuracy
Time Bases	0.1, 1 and 10 seconds ± 50 ppm from 0°-50° C.
Sensitivity	300 μ a, peak-to-peak into 10,000 ohms, 20 millihenries series load
Level Control Range	± 1 milliampere
Display Time	Adjustable 0.5 to 10 seconds (automatic reset). Display can be held indefinitely.
External Reset	From relay contact closure.
Supply Voltage	50-60 cps, switch selects taps at 105, 117 and 126 volts $\pm 10\%$ or 210, 222 and 231 volts $\pm 10\%$
Power Required	Approx. 115 watts
R.F. Oscillators	3 Type 6AU5 tubes
Dimensions	18 $\frac{1}{2}$ " wide by 8-23/32" high by 14 $\frac{1}{2}$ " deep, for standard relay rack or wall mounting
Weight	Approx. 55 lbs.
Price	\$1495.00 f.o.b. Richmond, Calif.

FEATURES

- Continuous Duty Reliability
- Long Component Life
- No Electron Tubes Except in Power Supply
- Provision for External Reset

Functions performed by the Magnetic EPUT® Meter are similar to those performed by conventional EPUT® Meters. A time base signal opens and closes a gate. The number of events that occurred during the time the gate was open are displayed on the illuminated panel of the magnetic counting units. If operated automatically, this result will be displayed from less than 0.5 to 10 seconds, and the instrument will then automatically recycle. If operated manually, the result will be displayed indefinitely until the "reset-start" button is depressed to obtain another reading.

The input amplifier of the Magnetic EPUT® Meter will respond to currents as small as ± 3 milliamperes from DC to 40,000 cycles per second. The input impedance of the meter is equivalent to 10,000 ohms resistance in series with an inductance of 25 millihenries. Up to 50 volts peak can be applied to the input of the unit without resultant damage to the circuit. A trigger level threshold adjustment provides input control over a range of ± 1 milliamperes.

An important feature of the Magnetic EPUT® Meter is the reliability of its time base. A 1 kc tuning fork controlled magnetic oscillator operates into a series of digital count-down magnetic frequency dividers which require no adjustment. Selectable gating intervals of 0.1, 1 and 10 seconds are provided, with accuracies of ± 50 parts per million from 0 to 50 degrees C. This results in a com-

plete time base unequalled for reliability, compactness, low power consumption and ruggedness.

An extremely useful feature of this instrument which finds wide industrial application is the external reset circuit. By placing the front panel display time control in the "infinite" position, the instrument will hold its display until reset either by manually depressing the reset button or by making a contact closure to the external reset circuit terminals at the main terminal strip. The maximum time delay between reset and the start of a new counting period is 25 milliseconds.

Magnetic EPUT® Meters are primarily intended for industrial applications where dust, vibration and other hazards are frequently encountered. Magnetic instruments are the logical choice for applications requiring long life with little "down time" for maintenance.

Examples of applications are:

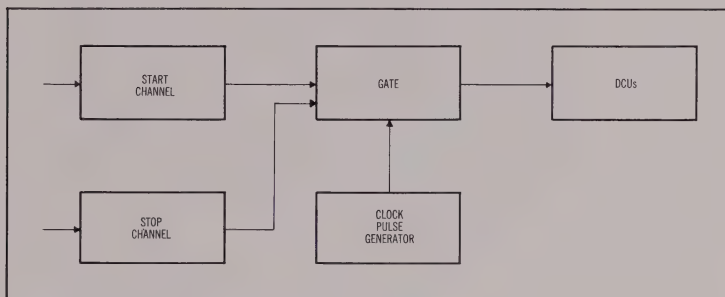
- Jet or piston engine test cells
- Dynamometer test stands
- Tachometry
- Process control
- Data reduction
- Hydraulic and pneumatic servo testing
- Acceleration-deceleration determination
- Measurement of linear or centrifugal speeds, forces, strains
- Measurement of any event occurring during a precise time interval

Data File 110 has been prepared to acquaint you with Beckman/Berkeley saturable reactors. Copies may be obtained free of charge from any representative or from the factory.

UNIVERSAL EPUT[®] METERS

Universal EPUT® Meters and Timers satisfy the need for versatile digital counters and timers of great accuracy, flexibility and ease of operation. Beckman/Berkeley Universal EPUT® Meters combine in one compact instrument the operational functions, of EPUT® Meters and time interval meters. From the large selection of Beckman/Berkeley Universal EPUT® Meters it is easy to choose a model at lowest cost which fits particular range or accuracy requirements and still retains the universal functions.

By switching a single control, arrangement of the circuits is varied so that the instruments function as a gated counter, time interval meter, period meter, ratio meter, or scanner. The block diagram shows major components of instruments in this series.



Input signals applied to the input channels are shaped into accurately spaced pulses and applied either to the gate or gate control circuitry. When applied directly to the gate, they are registered on the DCUs during the time that the gate is held open by the clock pulse generator. This is the basic Events-Per-Unit-Time (E/UT) measurement for normal frequency determinations. When the input pulses are applied to the gate control circuitry they control the gate and while they hold the gate open, accurate pulses from the clock pulse generator are counted. This is the basic Time Interval or Period measurement.

The Scan function is incorporated in most models to allow frequencies to be measured over a prolonged sampling time. It is manually controlled for the sake of overall accuracy. The Period functions are particularly useful for making highly accurate measurements of low frequencies. The A/B operating mode is made possible by the independent inputs. Two independent outputs permit A/B operation for determination of the ratio of two input frequencies. For straight digital ungated counting the operator merely selects the Count position of the function control.

Preset Universal EPUT® Meters use preset decimal counting units for their time base. These DCUs operate to divide any input signal by a preselected number which lets these instruments operate as flexible time base generators or preset controllers. Four-line binary-coded readout information may be used to operate digital printers, inline readouts, or other auxiliary equipment.

Beckman/Berkeley Universal EPUT® Meters feature maximum versatility in electronic counting equipment. Instruments in this group may be used for electrical tachometry, telemetering, frequency stability checks, relay and switch timing and as secondary frequency standards.

More complete information on their use is contained in Data Files 111 and 112, obtainable on request.



The Model 5230 Universal EPUT® and Timer combines many features usually found at a higher cost with low cost, light weight, and portability.

The Model 5230 employs a 10 KC crystal-controlled oscillator to generate timing clock pulses.

Any one of seven operational modes may be selected by positioning the FUNCTION control.

In E/UT function, components are arranged so that the input signal is counted for an interval of time determined by internally generated timing pulses. This function is useful in electronic tachometry, and other applications yielding relatively large count indications for a one-second or less counting period.

If the accumulated count is small, the accuracy and convenience of measurement may be increased by using the Period function where internally generated timing pulses are counted for a time determined by the period of the externally applied signal.

All the foregoing functions are supplied with a x10 function for taking ten second samples or ten cycle averages.

The Scan function extends E/UT measurements for any multiple of 1 second. This yields an increase in the

accumulated count by manually extending the sampling time.

On the Count function the counter behaves as a straight electronic counter, totalizing events applied to it.

The A/B and A/B x10 functions provide for making ratio or ratio x10 measurements where (A) is the higher frequency. The ratio or ten times the ratio is displayed in digital form. These measurements are possible because of the two independent input channels.

The TIM function is similar to the Period function except start and stop signals are now supplied on separate channels allowing isolated events to start and stop the counter.

Some applications of Universal EPUT® Meters are electronic tachometry, telemetering frequency stability, relay and switch timing, events counter, secondary frequency standard, timing generator, and measurements of high and low frequencies, ballistics, viscosity, elasticity, frequency ratio, and phase.

Berkeley Data Files 111, 112 have been prepared to acquaint you with some of the interesting and unique applications of these versatile instruments. Copies may be secured from any Berkeley engineering representative or from the factory.

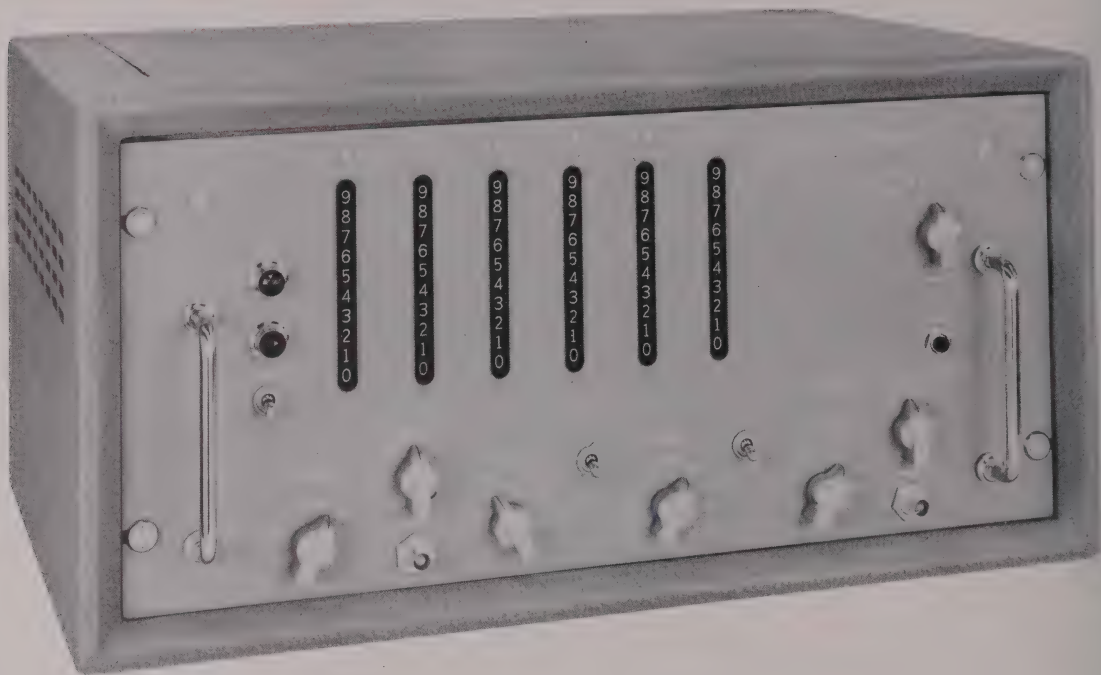
FEATURES

- High Quality at Moderate Cost
- Printed Circuits
- Compact Design — Portable
- Ease of Servicing
- Scan Function
- Simplified Controls

SPECIFICATIONS		Model 5230
Functions	E/UT, PER, TIM, SCAN, COUNT	
Count Capacity	4 digits	
Measurement Ranges		
Frequency	0-100 KC	
Time Interval	100 μ sec to 10^4 sec	
Period	0-10 KC	
Ratio	1 to 10^4 from 0-100 KC	
Time Bases	100 μ sec to 1 sec	
Accuracy	± 1 count $\pm$ osc. stability	
Oscillator Stability	1 part in 10^4 per day	
Sensitivity	0.25 volts rms	
Input Impedance	1 megohm, direct	
Trigger Slopes	Positive or negative	
Input Circuit Controls	Trigger voltage adjustments having ranges of ± 5 volts	
Self Test Facility	Check of all frequency dividers and decimal unit counters	
Display Time	Adjustable from .05 to 5 seconds when on automatic reset, indefinite when on manual reset	
Auxiliary Connections		
Frequency Jack	For introducing an external frequency	
Power Requirements	105, 117, or 126 volts $\pm 10\%$, 50-60 cps, 130 watts (supplied wired for 117v.)	
Dimensions	12" H x 8" W x 14" D	
Shipping Weight	30 lbs. (approx.)	
Price	\$575.00, F.O.B. Richmond, California	

MODIFICATIONS

Modification B	Incorporates additional circuitry to extend time base by a factor of 10. Price: \$70.00
Modification E	Extinguishes DCU's during scaling. Price: \$65.00
Modification H	Standard transformer replaced by unit having two tapped primary windings allowing operation from 210, 222, or 231 volts $\pm 10\%$ operation normally supplied. Frequency 50-60 cycles. Supplied wired for 222 volt $\pm 10\%$ operation with proper line fuses. Price: \$25.00
Modification P	Provides binary coded readout for driving Digital Recorder or Inline Readout. Price \$30.00



FEATURES

- **TEN MEGOHM INPUT IMPEDANCE.** Choice of Direct or a-c coupling.
- **INPUT STEP ATTENUATORS.** 100:1, 10:1, and 1:1.
- **ADJUSTABLE INPUT TRIGGER CONTROLS.** Measurements can be made in the presence of noise signals.
- **OUTPUT CLOCK PULSES FROM TIME BASE.** A secondary standard for calibration or a master time base for tandem operation of several units.
- **BINARY-CODED OUTPUT INFORMATION FROM EACH DCU.** Operates Berkeley digital recorders, new inline readouts, or data converters to drive IBM punches, electric typewriters, tele-typewriters, and analog strip chart recorders.

Models 7350 and 7360 Universal EPUT® Meters combine the functions of EPUT® Meters and time interval meters. They consist of two input channels and a gate, followed by a series of DCUs. The input channels are provided with step-attenuators in addition to trigger

level controls. Use of trigger level rather than gain controls allows adjustment of trigger levels to precise points on input signals. This permits accurate measurement of complex waveforms and provides discrimination against noise signals. Timing signals are derived from a highly stable crystal controlled oscillator, followed by an exact divider chain. Measurements are displayed in direct digital form.

Any one of ten functions may be selected by a single control. The 7350 and 7360 Universal EPUT® and Timers have the following operating modes: E/UT, TIM, A/B, Period, Count, A/B x 10, Period x 10, Scan, E/UT x 10, and Test.

The E/UT function provides counting for a precise period of time. This function yields a high count indication when used for measuring high frequencies. Scan and E/UT x 10 are methods of extending the sampling time to increase the accumulated count.

The TIM function is similar to the Period function except that start and stop signals are fed into separate input channels.

The A/B function permits ratios to be measured. The A/B x 10 function allows 10 cycle average to be measured by dividing the "B" frequency by 10.

In the Period position, low frequencies can be measured. The Period x 10 function yields a 10 cycle average useful for very low frequency measurements.

With the function control at COUNT, events are simply totaled.

The Test function lets the operator check the operation of the divider chain and DCUs.

Binary-coded output is available on a 40-pin connector at the rear of the instrument. This information will drive a Digital Recorder, Model 1452, or Berkeley In-Line Readouts.

Some applications of the Universal EPUT® Meter:

FREQUENCY

Tachometry
Telemetry
Events Counting
Flow Measurements
Ratio Measurements
Frequency Measurements, High and Low
Stability Checks
Secondary Frequency Standard
Phase Measurements

TIME

Precise Event Timing
Relay and Switch Timing
Timing Generator
Ballistics Measurements
Viscosity Measurements
Elasticity Measurements

Berkeley Data Files 111 and 112 have been prepared to acquaint you with some of the interesting and unique applications of these versatile instruments. Copies may be had free of charge through any Berkeley representative or from the factory.

SPECIFICATIONS	Model 7350	Model 7360
Functions	E/UT, TIM, A/B, Period, Count, A/B x 10, Per x 10, Scan, EPUT x 10, Test	
Ranges (Sine wave or pulse) Frequency Time Interval Period	0 cps to 100 Kc 10 μ sec to 10 ⁶ sec 0 cps to 100 Kc	0 cps to 1 MC 1 μ sec to 10 ⁷ sec 0 cps to 1 MC
Time Bases	10 μ sec to 10 sec decade steps or external frequency (0-100 Kc) or (frequency only) any multiple of 1 or 10 seconds	1 μ sec to 10 sec decade steps or external frequency (0-1 MC) or (frequency only) any multiple of 1 or 10 seconds
Accuracy	± 1 count $\pm$ crystal stability	± 1 count $\pm$ crystal stability
Crystal Stability	± 3 parts in 10 ⁶ per week	± 3 parts in 10 ⁷ per week
External Standard Input	0-100 Kc, 3 volts rms	0-1 MC, 3 volts rms
Output Frequencies	1 cps to 100 Kc, decade steps	1 cps to 1 MC, decade steps
Sensitivity (all functions)	0.1 V rms	
Input Impedances	10 Megohms, Direct — or AC — coupled	
Trigger Slopes	Positive or Negative	
Input Circuits	Step Attenuators with Trigger Level Adjustments having ranges of ± 1 , ± 10 and ± 100 volts	
Test	Check of all frequency dividers and counters	
Standardization	May be standardized against WWV or other external frequencies	
Display Time	Adjustable 0.1 to 10 seconds (automatic electronic reset). Display can be held indefinitely (manual reset)	
Printer Connection	Binary Coded output information from DCU's to operate Model 1452 Digital Printer or Series 1440 Data Converters, inline readout accessories.	
Power Requirements	105, 117, or 126 volts, $\pm 10\%$, 50-60 cps, (supplied wired for 117 v.) Model 7350, 265 watts; 7360, 320 watts	
Dimensions	Cabinet Mount: 10 $\frac{1}{4}$ " H x 20 $\frac{3}{4}$ " W x 16 $\frac{1}{2}$ " D. Rack Mount: 8 $\frac{3}{4}$ " H x 19" W x 16" D	
Shipping Weight	Approx. 60 lbs.	

MODIFICATIONS:

Modification C	Adds 4 digit mechanical register, obscures last DCU. Price: \$80.00
Modification E	Extinguishes DCU's during scaling. Price: \$65.00
Modification G (7350)	Provides automatic time base scanning. Automatic operation obtained by the addition of a preset timer. Permits selection of precise time bases from 3 to 6 seconds. Operation, including recycling, is completely automatic. Price: \$130.00
Modification H	Standard transformer replaced by unit having two tapped primary windings allowing operation from 210, 222 or 231 volts $\pm 10\%$ in addition to the 105, 117, or 126 volt $\pm 10\%$ operation normally supplied. Frequency 50-60 cycles. Supplied wired for 222 volt $\pm 10\%$ operation with proper line fuses. NOTE: Crystal oven is rewired to operate only when Power Switch is ON. Price: \$25.00
Modification J (7360)	Provides 2 mc B channel and higher frequency DCU's (711AH and 713AH instead of 707AH and 705AH) to extend upper range to 2 mc. Price \$80.00
Modification K	Increases input sensitivity from 0.1 volts to 5 millivolts at 5 cps providing operation from flow meter transducers. Price \$50.00
Modification R	Provides for relay rack mounting. No charge when specified on original order
Modification V (7350)	Provides drive circuit for driving remote indicator, Model 1941 or 1941X. Price: \$50.00
Price	Model 7350: \$945.00; Model 7360: \$1245.00



FEATURES

- FREQUENCY MEASUREMENTS to 10 mc — additional compatible equipment available to extend coverage to 10 K mc.
- SEVEN DIGIT Readout.
- ACCURATE CLOCK SIGNALS from .1 microsecond to 1 second available for external use.
- BINARY-CODED OUTPUT information from all DCUs.
- THREE SEPARATE input channels
 - A, B, Channels 0-3 mc
 - E Channel 20 cps—10 mc
- SIMPLIFIED CONTROLS—operation easily learned by non-technical personnel.
- TEN DISTINCT OPERATIONAL MODES in addition to the self test facility.
- 0.1 MICROSECOND COUNTER RESOLUTION — Time interval measurement from 0.3 μ sec to 107 sec.
- DECADE TIME BASE from 10-6 to 1 sec.

The Model 7370 Universal EPUT® Meter offers you the most accurate and convenient method of high frequency measurement on the market. Here, in a single instrument, are all the functions of a universal counter and timer, coupled with extended coverage. Frequency measurements up to 10 K mc are rapidly and easily made with the Model 7580 Transfer Oscillator.

Virtually every counting and timing application can be satisfied without plug-ins, and in a light, moderate size portable instrument.

This instrument consists of three input channels, a time base, and a gate followed by seven DCUs. Two of the input channels are equipped with trigger level step attenuator and slope switch controls, and have a range from 0 to 3 mc. The third channel has a step attenuator, and a range of 20 cps to 10 mc. The time base has a precise oven stabilized crystal controlled 1 mc oscillator followed by a series of precise dividers. A frequency multiplying stage is used to supply pulses of .1 microsecond separation.

Any one of eleven modes of operation may be selected with the function control:

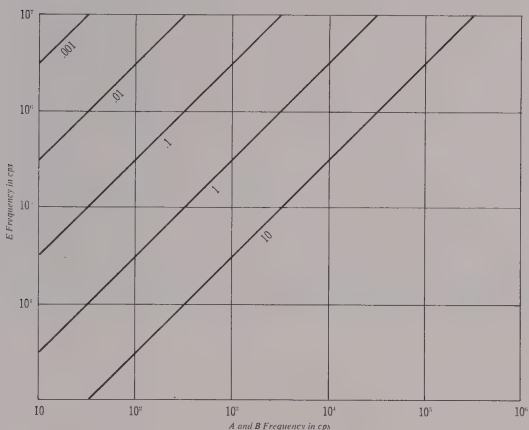
- | | | | |
|------------|------------|--------------|----------|
| 1. E/UT | 4. E/B-A | 7. E/UT x10 | 10. SCAN |
| 2. Per-B | 5. E/B | 8. Per-B x10 | 11. TEST |
| 3. TIM B-A | 6. Count-E | 9. E/B x10 | |

The E/UT function provides counting for a precise period of time. This function is useful for directly measuring frequencies up to 10 mc. E/UT x 10 and Scan extend the sampling time in order to increase the accumulated count.

The Period-B function is used for making low frequency measurements. The Period — B x 10 function yields a 10 cycle average.

The TIM B-A function is similar to the Period function except that the start and stop signals arrive on separate input channels. For frequency ratio measurements, several modes of operation are available. An E/B and E/B x 10 are used for simple ratio measurements. The higher frequency is applied to the "E" channel, the lower to the "B" channel and the ratio read directly on the DCUs. For low ratios a x10 feature is available to divide the lower frequency by 10 thus giving an accumulated count higher by a factor of 10. E/BA, is provided. In this function two lower frequencies are used. Precise phase measurements to high accuracies are simple using this function. For example, if two 400 cps signals are introduced into the "A" and "B" channels and a 1.44 mc signal introduced into the "E", the phase angle between the 400 cps signals may be determined to 0.01 degree.

The graph will serve to illustrate the accuracy available for several frequency combinations.



In the Count-E function the instrument behaves as a straight 10 mc electronic counter, totalizing events applied to it. The instrument is also provided with an "Off" function so it may be gated off manually from the Count-E function. This permits successive accumulative readings.

The Test function lets the operator check operation of the divider chain and the DCUs.

Binary-coded output is available on a connector at the rear of the instrument. This information will operate a digital recorder, summary punch or other data processing equipment, or in-line readouts.

A partial list of applications includes:

FREQUENCY

Frequency Measurements
Secondary Frequency Standard
Phase Measurement
Telemetry
High Speed Events Counting
Stability Checks
Calibration of Frequency Generators
Frequency Ratio Measurements

TIME

Events Timing
Accurate Low Frequency Measurements
Calibration of Pulse Generators
Ballistics Measurements
Viscosity Measurements
Elasticity Measurements

Data Files have been prepared to acquaint you with some of the applications of these versatile instruments. Copies may be had free of charge from any Berkeley representative or from the factory.

Data File 111:

"How To Make Frequency Measurements"

Data File 112:

"How To Make Interval Measurements"

SPECIFICATIONS	Model 7370
Functions	E/UT, Per-B, TIM A-B, E/A-B, E/B, E/UT x 10, Per-B x 10, E/B x 10, Scan, Count-E, Test
Count Capacity	Readout 7 digits
Measurement Ranges:	
Frequency	20 cps — 10 mc
Time Interval	0.3 μ sec. to 10^7 sec.
Period	0-3 mc
Ratio	1- 10^7 from 20 cps to 10 mc
Time Bases	0.1 μ sec. — 10 sec.
Accuracy	± 1 count $\pm$ osc. stability
Oscillator Stability	± 3 parts in 10^7 per week
Output Frequencies	1 cps to 10 mc in decade steps
External Standard Input	0-1 mc, 3 volts rms
Sensitivity	0.1 volt rms (C) 0.2 volts rms (A and B)
Input Impedance	10 megohm, direct or a-c coupled (A and B)
Trigger Slopes	Positive or Negative (A and B only)
Input Circuit Controls	Step attenuators and trigger voltage adjustments having ranges of ± 1 , ± 10 , and ± 100 volts (A and B input channel) Step Attenuator (C input channel)
Standardization	May be standardized against WWV or other external frequencies
Display Time	Adjustable from 0.1 to 10 seconds when on automatic reset, indefinite when on manual reset
Auxiliary Connections	Binary coded information from the DCU's to operate a printer or other accessories
Frequency Jack	For outside utilization of the internal frequency or introducing an external frequency
Time Jack	Accurately spaced pulses available for use as a clock signal
Ext. Reset	Permits reset by shorting two pins of connector
Other Features	3 input channels — A and B dc — 3 mc C-20 cps to 10 mc
Power Requirements	105, 117, or 126 volts $\pm 10\%$, 50-60 cps, 320 watts (approx.)
Dimensions	Cabinet Mount: $10\frac{1}{4}$ " H x $20\frac{3}{4}$ " W x $16\frac{1}{2}$ " D
Modifications	C, H, R Standard Modifications
Price	\$1975.00, F.O.B. Richmond, California



FEATURES

- **PRESET TIME BASE**—for digital indications of flow, speed, pressure, etc. without conversion.
- **BROAD ADAPTABILITY**—seven distinct operating modes.
- **TOTALIZE FUNCTION**—for indicating the sum of groups which are preselected and counted by the instrument.
- **PERIOD MEASUREMENT**—with range selection between 1 and 9,999 cycles of the unknown.
- **BINARY CODED OUTPUT**—for operating a digital printer, in-line indicator, or data reduction systems.
- **UNUSUAL FLEXIBILITY**—also operates as a frequency divider, a single preset counter, and pulse generator of varying frequencies.

Beckman/Berkeley Models 7351 and 7361 Preset Universal EPUT® Meters combine preset DCUs with the functions of a Universal EPUT® and Timer to provide seven distinct operating modes.

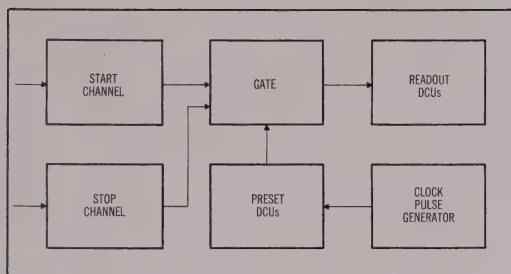
The input channels may be either ac or direct coupled with step attenuators and trigger level controls in addition to slope switches to permit accurate measurement of complex waveforms or in the presence of noise signals.

Preset DCUs are controlled by knobs located in a vertical column on the left hand side of the front panel.

The clock-pulse generator consists of a 100 kc oven stabilized crystal controlled oscillator and a frequency divider chain composed of an electronic divider and four preset DCUs.

Berkeley modular chassis construction is used throughout. The preset and readout DCUs are reliable, easy to read, plug-in units.

The principal components of the instruments are two input channels, gate, the time base, and a series of readout DCUs. The **FUNCTION** control lets the operator arrange the components electrically for various modes of operation. The simplified block diagram will serve to illustrate the principal circuits connected by E/UT or Time Interval Meter operation.



To use the instrument, simply select the desired mode of operation and introduce electrical signals of proper strength and frequency at the input channels. Phenomena of a non-electrical nature may be measured through the use of appropriate transducers, which supply pulses representing events to be counted, timed, or controlled. The presettable time base permits the instrument to be "calibrated" for direct readout in any unit of measure such as gallons per minute, revolutions per minute, etc.

Preset DCUs, in addition to providing increased flexibility for "conventional" measurements, enables operation as preset counters and time interval generators. As a preset counter, the instrument produces an output pulse after a predetermined number of input signals. As a time interval generator, the separation of output pulses is determined by the preset DCUs which are now counting

time base signals. For the Totalize function, an external signal is fed to the preset DCUs. Each time the preset number is reached, an output pulse is produced, registered, and totalized by the readout DCUs. The instrument is now operating as a preset counter working in conjunction with an electronic counter.

Varied applications are possible because, here in a single instrument, the performance characteristics of an EPUT® and Time Interval Meter, Preset Counter and Ratio Meter coalesce. High accuracy coupled with rugged construction combine to produce an instrument well suited to industrial and laboratory applications.

The computing feature of the preset time base ideally equips these instruments for flow measurement and other uses where several variables are encountered. For example, the computing feature simplifies making corrected flow measurements on substances whose temperature (viscosity) changes from time to time. Modification "K" increases the sensitivity of the instrument for flow measurements involving low rates or reduced transducer output.

Included among the applications are:

FREQUENCY
 Flow Measurements
 Tachometry
 Telemetry
 Frequency Measurement
 Secondary Frequency Standard
 Phase Measurement

TIME INTERVAL
 Events Timing
 Time Interval Generator
 Preset Counter
 Viscosity
 Ballistics
 Pressure

SPECIFICATIONS	Model 7351	Model 7361
Functions	E/UT, Period, TIM, Time-Interval-Generator, A/B, Totalize, Scan, Test	
Count Capacity	Readout 5 digits	Readout 6 digits
Range Frequency	0-100 kc	0-1 mc
Period	1 to 9,999 periods of inputs from 0 cps to 10 kc	
Time Interval Generator	0.1 to 9,999 milliseconds	
Totalize	Divides frequencies between 0 and 10 kc by any number from 1 to 9,999	
Time Bases	Variable in 0.1 millisecond increments from 0.1 milliseconds to .9999 seconds and in 1 millisecond increments from 1 millisecond to 9.999 seconds 10, 100, and 1000 μ seconds For outside utilization of the internal utilization or introducing an external frequency Output of Preset DCU's	
EPUT & TIG		
Period		
Freq. Jack		
Time Jack		
Other Features	4 DCU's used to give the variable time base for E/UT, extend range of PER, and A/B	
Power Requirements	105, 117, or 126 volts $\pm$ 10%, 50/60 cps, (supplied wired for 117v.), 300 watts (approx.)	
Dimensions	Cabinet Mount 10 $\frac{1}{4}$ " H x 20 $\frac{3}{4}$ " W x 16 $\frac{1}{2}$ " D. Rack Mount 8 $\frac{3}{4}$ " H x 19" W x 16" D	
Weight	50 pounds (approx.)	
Price	Model 7351: \$1295.00; Model 7361: \$1445.00	

MODIFICATIONS:

Modification B (7351)	Adds a fifth preset DCU (Not available on 7361 or with modification C). Price: \$70.00
Modification C	Adds a 4 digit mechanical register. Price: \$80.00
Modification E	DCU's extinguished during scaling period. Price: \$65.00
Modification H	Standard transformer replaced by unit having two tapped primary windings allowing operation from 210, 222, or 231 volts $\pm$ 10% in addition to the 105, 117, or 126 volt $\pm$ 10% operation normally supplied. Frequency 50-60 cycles. Supplied wired for 222 volt $\pm$ 10% operation with proper line fuses. NOTE: Crystal oven is rewired to operate only when Power Switch is ON. Price: \$25.00
Modification K	Input sensitivity 5 millivolts at 5 cps permitting operation from flow meter transducers. Price: \$50.00
Modification L	Provides remote preset feature. Price: \$50.00
Modification R	Rack Mounting. No charge on original order.
Modification V	Provides for driving Explosion Proof Remote Indicator Models 1941X and 1951X

FREQUENCY METERS AND ACCESSORIES

Precise frequency measurements from very low periodic functions to 1005 megacycles may be performed quickly and easily with compatible Beckman/Berkeley equipment featuring complete coverage with digital accuracy, this frequency measuring equipment renders calibration charts, tables, and mathematical calculation unnecessary. Errors, part and parcel of such devices, are minimized.

Beckman/Berkeley offers the user a distinct approach to high frequency measurements. The heterodyne method uses a heterodyne unit for the 2 to 42 mc range and reference generators with associated plug-ins for the 42-1005 mc range.

Because of their inherent high accuracy and convenience, this system centers around Beckman/Berkeley Universal EPUT® Meters such as Models 5571, 7360J, or 7370. These versatile instruments serve as both precise reference frequency generators and prime indicating devices. They also perform many other timing measurements.

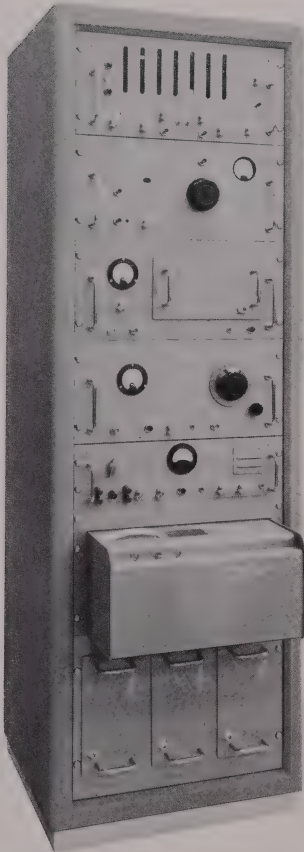
The heterodyne section of the Model 5571 Frequency Meter is basic to the Beckman/Berkeley system. It mixes the unknown frequency with an internally generated standard frequency and supplies the difference frequency to the decade indicator unit. The unknown frequency may then be read directly from the heterodyne and indicator unit.

The Model 5580 Reference Generator and associated plug-ins supply an internally generated reference frequency to mix with the unknown. The difference frequency is applied to the Model 5571 Heterodyne unit and determined accordingly. In the 502 to 1005 megacycle range Model 5582B UHF Converter and plug-ins are available.

For broad range communications monitoring the Model 7700 Frequency Measuring system offers a compact system for monitoring the frequency range of 0.54 to 30.5 mc. This relatively low cost system features continuous coverage and digital readout for the unknown frequency.

Model 905 WWV Receiver rounds out the Beckman/Berkeley line of frequency measuring equipment. The Model 905 permits standardization of the equipment with WWV or WWVH on any of their 6 transmission bands.

Typical frequency measuring system showing (top to bottom) Model 5571 Frequency Meter for 0-42 mc range, Model 5580 Reference Generator with Model 5581 Plug-in Unit installed (thirteen plug-in units in 5581 series extend the range of the 5571 to 515 mc), Model 5585 Selective Amplifier providing 100 microvolt sensitivity for the Model 5571 in the 2-42 mc range, Model 905 WWV Receiver to calibrate Model 5571 within ± 2 parts in 10^8 of WWV for use as a secondary frequency and time standard, and the Model 1452 Digital Recorder which automatically prints the last six digits of the frequency under measure (invaluable for taking data on oscillator stability, monitoring frequency, etc.)





Berkeley vhf and uhf Converter Units are used with the Berkeley Model 5571 Frequency Meter to measure and indicate in digital form frequencies up to 515 megacycles with an accuracy of ± 1 cycle, $\pm$ the crystal stability of the Model 5571. Frequencies from 0 to 42 megacycles are measured directly on the Model 5571 Frequency Meter. The Model 5580, with plug-in units of the Model 5581 series, covers the range from 42 to 515 megacycles and is used directly with the Model 5571 Frequency Meter. Use of plug-in units covering certain fixed bands eliminates costly wide band amplifiers and decreases overall size.

How the Model 5580 Works

The Model 5580 contains a power supply, frequency multipliers, a wide-band amplifier, a level meter and an output circuit. The Model 5581 Plug-in Units contain additional frequency multipliers and a mixer circuit.

The one-megacycle reference crystal frequency from the Model 5571 is multiplied to the desired known harmonic or base frequency and applied to the mixer of the 5581. The output (difference frequency) of the mixer is fed to the amplifier of the 5580. Since the bandpass of this amplifier, is from 2 to 35 only difference frequencies in this range are passed to the Model 5571. The standard Model 5580 can also be used as a wide band amplifier in the range from 2 to 35 megacycles with a gain of 30 db.

The Model 5581/4 vhf plug-in unit differs from the uhf plug-in units in that it has 5 selectable crystal controlled base frequencies of 40, 60, 80, 100 and 120 megacycles and therefore covers the range of 42 megacycles to 155 megacycles. The uhf converter units generate by frequency multiplication a single base frequency between 150 and 480 megacycles. Units are coded for easy identification according to the base frequency employed. For instance, 5581/15 and 5581/45 denote base frequencies of 150 megacycles and 450 megacycles respectively.

The Model 5581/4 vhf Plug-in Unit covers the range of 42 megacycles to 155 megacycles. Frequency reading is shown as the sum of the numerical marking on a rotary selector knob of the Model 5581/4 and the number indicated on the turret and decade panels of the Model 5571. Uhf Plug-in Units, Model 5581/15 through 5581/48 cover 33 Megacycle bands between 152 and 515 megacycles. Here frequency reading is made in digital form as

the sum of the base frequency of the plug-in unit and the indication on the Model 5571.

Applications

Telemetry, Tachometry, Frequency Stability, Relay and Switch Timing, Events Counter, Secondary Frequency Standard, Timing Generator and measurement of high and low Frequencies, Phase, Ballistics, Viscosity, Elasticity, and Frequency Ratio.

SPECIFICATIONS	5571	5580	5581/4 5581/48
Range	Frequency—0 cps to 42 mc. Time Interval—1 μ sec. to 10^7 seconds. Period—0 to 1 mc over 1 cy. of input, 0-100 Kc over 10 cy. of input	Determined by plug-in unit	see range table
Input Impedance	10 Megohms, Direct-or AC-coupled Amplifiers (100 ohms, 2-42 mc)		50 ohms
Input Sensitivity	0.1 volt rms		0.1 volts rms
Trigger Slope	Positive or negative on start, stop, and period channels		
Time Bases	Frequency—0.000001 to 10 seconds in decade steps. Period or Time Interval Measurement—1 mc to 1 cps in decade steps, or externally applied frequency (0-1 mc)		
External Standard Input	1 mc, 3 volt rms into impedance of 1800 ohms $\pm$ 40 mmf		
Output Frequencies	1 mc, 100 Kc, 10Kc, 1 Kc, 100 cps, 10 cps, or 1 cps pulses at rear connector selected by time base switch		
Accuracy	$\pm$ 1 Count of unknown (or time base) $\pm$ crystal stability		
Crystal Stability	$\pm$ 3 parts in 10^7 /week. May be standardized against WWV		
Display Time	Adjustable 0.2 to 5 seconds (automatic reset). Display can be held indefinitely		
Test	Automatic check is provided to test operation of all frequency dividers and counters		
Printer Connection	To Model 1452 Digital Printer or Series 1440 Data Converter, Model 5916 Inline Readout, etc.		
Power Requirements	117 volts, $\pm$ 10%, 50-60 cps, approximately 260 watts.		
Dimensions	Cabinet Mount (Model 5571) 19" H x 20 $\frac{3}{4}$ " W x 16" D (overall) Rack Mount (Model 5571R) 17 $\frac{1}{2}$ " H (2 - 8 $\frac{3}{4}$ " panels) x 19" W x 16" D.	20 $\frac{3}{4}$ " x 10 $\frac{1}{2}$ " x 15" 8 $\frac{3}{4}$ " x 19" panel	panel 6" x 11"
Shipping Weight	Cabinet Mount (Model 5571) — approx. 122 lbs. Rack Mount (Model 5571R — approx. 105 lbs.	64 lbs.	14 lbs.
Finish Cabinet	Wrinkle blue	Wrinkle blue	
Panel	Smooth gray	Smooth gray	Smooth gray
Modification H	Standard power transformer replaced, providing operation from 220 or 117 volts $\pm$ 10%, 50-60 cps, \$25.00	Modification H (same as 5571)	
Price	\$1825.00	\$300.00	5581/4 \$175.00 all others \$125.00

MODEL 5582B UHF CONVERTER AND MODELS 5581/50 THROUGH 5581/90 PLUG-IN UNITS



FEATURES

- Coverage to over 1000 megacycles
- Accuracies to one part in 10 million
- Direct Decimal Readings
- No Interpolation
- No Scope Patterns to Interpret
- No Charts or Calculations
- Simple to Operate

APPLICATIONS

Monitoring of UHF television, studio-transmitter link, radio navigation, scientific and medical equipment frequencies.

Measurement of CW and AM signal frequencies with extreme accuracy.

Signal generator calibration.

Precision VHF and UHF standard frequency generator.

Berkeley now offers complete frequency coverage from DC to 1005 megacycles with a new UHF Converter and five new plug-in units. The six instruments extend the range of Berkeley's well-known Model 5571 Frequency from 42 to at least 1005 megacycles. A new high in measuring accuracy at these frequencies — at least a decade higher than any other system — can be achieved because of the unique design principle used. The equipment is simply constructed and easy to operate. Even non-technical personnel can use it with confidence.

Design

Each Plug-In Unit generates a precise standard reference frequency obtained by multiplication of the one-megacycle crystal oscillator from the Model 5571 Frequency Meter. (An external standard may be used if desired.) In the Model 5582B, a crystal converter mixes this reference signal with the unknown frequency. The difference of the two frequencies, in the region of 2 to 105 megacycles, passes to the Model 5571 (or Model 5580 VHF

Converter with Model 5581/4 Plug-in Unit) for direct measurement of the less significant figures.

Each range of the 5582B covers a band of frequencies 103 megacycles wide, beginning at 500, 600, 700, 800, or 900 megacycles, depending upon the Plug-In selected. Accuracy of measurements is limited only by the plus or minus 1 count error from the Model 5571 counter and the accuracy of the one-megacycle reference input frequency.

When used with the Model 5571, the reference frequency has a short term stability of plus or minus 1 part /10⁷, and a long term stability of plus or minus 3 parts /10⁷ per week. The entire system may be calibrated against WWV or another primary frequency standard at any time, even while frequency measurements are being made, yielding accuracies as great as plus or minus 2 parts /10⁸.

Operation

No controls are used on the new plug-in units and only three are used on the 5582B. These are the power on-off switch, a "set level-use" switch, and a sensitivity control. A panel meter on the 5582B displays the level of the signal being measured. This detects the presence of an input with the range of the plug-in unit and aids in setting the sensitivity control to the proper operating point when the switch is in the "set-level" position.

When the switch is turned to the "use" position, the difference frequency is measured by the 5581/4 or 5571. The unknown frequency is read as the sum of the reference signals generated by the 5581 plug-ins and the reading of the 5571.

Because no transfer oscillator is used, no correction charts or sample calculations are needed to determine the operating range. There are no oscilloscope patterns to interpret. All measurements can be performed in one second or less. No adjustments must be performed between readings to insure accuracy.

Applications

The Berkeley Frequency Measuring System finds wide use in the radio, telephone, guided missile and radar fields. It performs such jobs as oscillator calibration, frequency monitoring, amplifier and receiver testing. It also serves as a time standard and secondary frequency standard.

Other Accessories

The last six significant figures of a measurement can be printed automatically on the inexpensive Model 1452 Digital Recorder. Data also may be displayed on the new Model 5916 In-Line Readout. Details on these and other accessories will be sent upon request.

SPECIFICATIONS	Model 5582B Reference Generator
Frequency Range	502 to 1005 megacycles, depending on plug-in unit selected
Sensitivity	1 milliwatt
Input Level Range	0 to +20 dbm
Output Level	0.1 volts rms
Output Frequency Range	2 to 105 megacycles
Input Impedance	50 ohms
Output Impedance	100 ohms
Connectors	BNC
Accuracy	Same as basic frequency meter. No reduction of accuracy occurs
Size (including plug-in unit)	15¼" H x 20¾" W x 16" D (cabinet mount) — 14" H x 19" W x 15" D (rack mount)
Finish	Panel: Smooth gray — Cabinet: Wrinkle blue
Power requirements	117 volts ± 10%, 50-60 cps, 235 watts
Price	\$2500.00

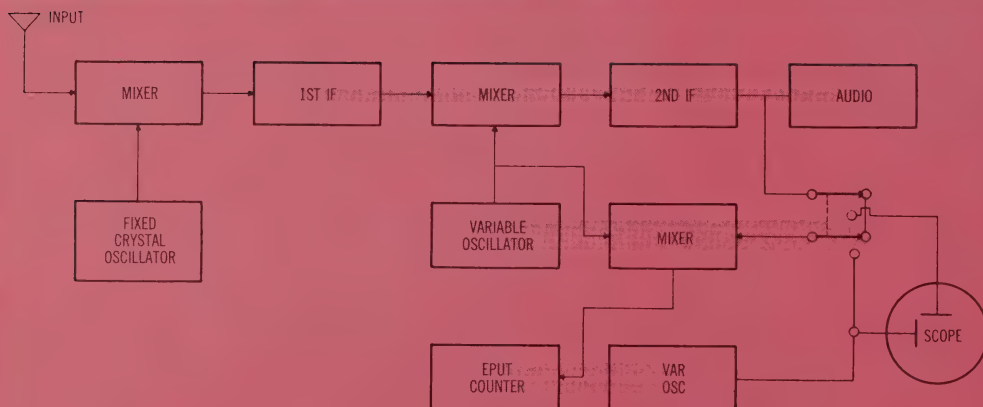
Models 5581/50 through 5581/90 Plug-in Units

Frequency Range	Model 5581/50:	502 to 605 MC
	Model 5581/60:	602 to 705 MC
	Model 5581/70:	702 to 805 MC
	Model 5581/80:	802 to 905 MC
	Model 5581/90:	902 to 1005 MC
Size	5¼" H x 19" W x 8¾" D (Fits into Model 5582B)	
Finish	Panel: Smooth gray	
Price	\$300.00	

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MODEL 7700 SENSITIVE FREQUENCY MEASURING SYSTEM



The Beckman/Berkeley Model 7700 Sensitive Frequency Measuring System makes quick, accurate measurements of virtually all types of radiated signals in the 0.54 to 30.5 megacycle frequency range. Owing to the extreme sensitivity of the Model 7700, it is possible to derive measurements from one microvolt signals with an error not exceeding 1 part in 10^7 . This is the only communications band frequency measuring system using an electronic high speed counter for automatic digital readout.

The system consists of three basic units, a broad range communications receiver, a translator unit, and a time gated counter that serves as the indicator. Main circuits are delineated on the accompanying function diagram.

The receiver has a full complement of controls. Included are band width, beat frequency pitch, RF gain controls. An audio system is included for aural monitoring. Radiated frequency under measure is selected by tuning the receiver unit to the specific broadcast. Amplification, discrimination, and interference rejection circuitry only passes the carrier frequency under measure to the counter.

Actual measurement consists of heterodyning the unknown signal with a fixed crystal oscillator, passing it through a tuned variable IF amplifier, and then mixing it with the output of the highly stable variable oscillator so that constant frequency output is obtained. This output is fed to a second IF stage and heterodyned with the variable oscillator frequency so that the absolute frequency of the variable oscillator is cancelled out. The converted output is further amplified and applied to the counter and displayed as a direct digital reading, scaled to a precise 1 second time interval.

A 2 inch cathode ray tube is used in the translator unit to accurately determine the frequency of interrupted carrier, multiplex, frequency shift keyed, and over-modulated AM transmissions. The unknown is compared on the 2 inch cathode ray tube to a frequency generated by a variable oscillator with an exceptional high short term stability. When a suitable null is observed, the unknown frequency can be read from the counter.

FEATURES

- Direct Reading — Counter speed, convenience and accuracy
- High Sensitivity — 1 microvolt for all signal transmissions
- Adjustable Band Width Tuning — 100 cps to 6 kc for interference rejection.
- Flexibility — measures AM, ICW, frequency shift keyed and multiplexed signals
- Exceeds FCC Specifications — complies with Part 15 of FCC Rules and Regulations
- Wide Range Coverage — .54 to 30.5 mcs

Model 7700 Specifications:	
Frequency Range	.54 - 30.5 mcs
Frequency Bands	30 bands 1 mc each
Sensitivity: 10 db s/n	.54-1.5 mc 15 μ v 1.5-30.5 mc 5 μ v
Direct Measurement	less than 5 μ v
Substitution Measurement	less than 1 μ v
Selectivity	adjustable from 1 kc to 6 kc, also has crystal filter
AVC	less than 3.5 db change from 5 to 125,000 μ v
S. Meter	calibrated to 100 db over AVC threshold
Power Out	1.5 w at 1 kc less than 15% distortion
Audio Response	3 db down at 200 cps and 7 db at 2500 cps
Audio Output Impedance	4 and 600 ohm
RF Input Impedance	high impedance single ended antenna
Power Requirements	400 watts at 115 v 50/60 cps
Dimensions	3 panels, 24½" over-all (high) 17" over-all (deep), 19" over-all (wide)
Weight	approximately 100 pounds
Accuracy (over-all)	crystal accuracy $\pm$ 1 cps
Crystal Accuracy	calibrating standard $\pm$ 1 count
Price	\$3500.00, F.O.B. Richmond, Calif.



SPECIFICATIONS

Frequency Coverage	2.5, 5, 10, 15, 20 and 25 mcs selectable by a single front panel switch
Sensitivity	1 μ v will produce AGC action on any band
Selectivity	Approx. ± 1 kc at -3 db without audio filters, allowing clear passage of WWV time "ticks"
Audio Filter Characteristics	Initial Slope of Rejection Filters: Better than 70 db/octave Selectivity at 3 db down: approx. 50 c/s; at 6 db down: approx. 100 c/s Ratio of response to selected WWV tone to any other WWV tone: approx. 20 db Rejection of frequencies far off selected frequency: better than 30 db
Output Impedance	3.2 ohms
Image Rejection	Approx. 60 db
Antenna Inputs	Single ended or balanced, 300 ohms or nominal
Tube Complement	1-5Y3GT 1-6AS6 1-6J6 1-6AN8 3-6BA6 2-12AT7 1-6AQ5 1-6CG7 2-12AU7
Power Requirements	105-130 volts, 50-60 cps, approx. 125 watts
Mounting	Cabinet or standard 19" relay rack size
Outside Dimensions: (Rack) (Cabinet)	5 $\frac{1}{4}$ " high x 19" wide x 13 $\frac{1}{2}$ " deep — 18 lbs. 7 $\frac{1}{4}$ " high x 21" wide x 14 $\frac{1}{2}$ " deep — 25 $\frac{1}{2}$ lbs.
Price: (Rack) (Cabinet)	\$525.00 f.o.b. Richmond, California \$550.00 f.o.b. Richmond, California

FEATURES

- All Six Frequencies Selectable by Front Panel Switch
- All Three Audio Filters Selectable by Front Panel Switch
- 1 Microvolt Sensitivity On All Bands
- Six Individual Crystals
- Available in Cabinet or Rack Mounting
- Modular Construction
- Blower Cooled

DESCRIPTION:

The Model 905 WWV Receiver is a high quality instrument designed to conveniently and accurately utilize the standard time and frequency broadcast of National Bureau of Standards' radio stations WWV and WWVH. Carefully designed for optimum operation at these frequencies, this receiver provides laboratories and industries with primary standard times and frequencies through the use of a compact, convenient and reliable unit.

The model 905, incorporating 6 individual crystals for maximum convenience, accuracy and stability, receives all six WWV broadcast frequencies, maintaining high selectivity and sensitivity, extremely stable tuning and excellent image rejection. This complete coverage permits reception even under adverse conditions. A logarithmic signal strength meter is provided for precise tuning. Local signals can be accurately measured by observing a zero beat on the meter or aurally monitoring the internal loudspeaker. An audio output jack is also provided for headphones or external reproducing devices. When this jack is in use, the internal loudspeaker is automatically disconnected.

For maximum convenience all controls are front panel mounted. Any one of the six WWV frequencies may be selected by means of a single front panel switch without the necessity of changing coil assemblies, crystals, etc. Audio filters are readily selected in the same manner. RF, audio gain, tuning and limiter threshold controls are conveniently positioned.

The highest quality components are used throughout, assuring long and reliable service. This precision instrument is available as a standard rack mounting unit or complete with its own cabinet for bench use.

Design

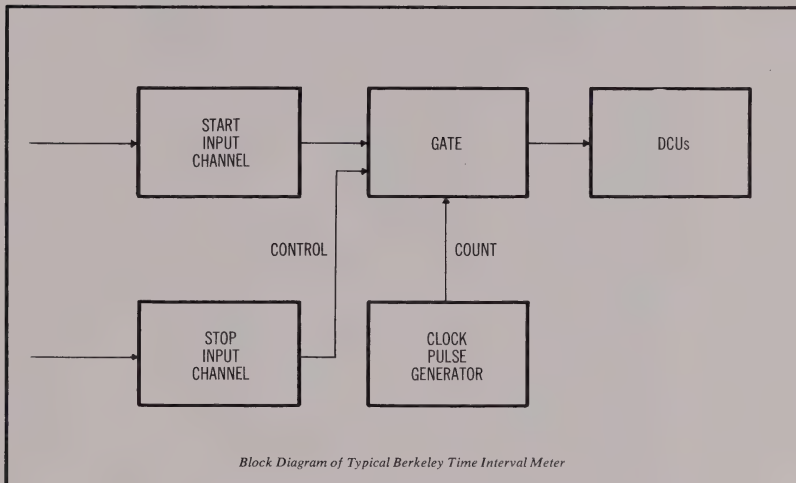
The Model 905 WWV Receiver is a 13 tube, high selectivity, dual conversion superheterodyne type of receiver. Input from the antenna is fed through one stage of RF amplification before being combined in a low noise mixer with the signal from a high stability crystal controlled local oscillator. The resulting relatively high IF frequency, 1.6 mcs, provides excellent image rejection. After amplification at this frequency, a second heterodyning process reduces the signal frequency to 50 kcs for effective sideband discrimination. The local signal for this second heterodyning process is obtained from a highly stable local oscillator, the frequency of which may be varied slightly by means of a front panel control to allow for absolute maximum receiver sensitivity and extremely precise tuning. Once set on any WWV frequency, this control requires no further adjustment.

After amplification at 50 kcs, the signal is detected by an infinite impedance type of detector having a large dynamic range and negligible distortion. The intelligence, now having been removed from the carrier, is next fed to a variable threshold limiter in which any large, undesirable noise pulses are significantly reduced. This is followed by a high gain negative feedback amplifier which provides for selective transmission, and finally the selected audio signal reaches a power output stage which drives the loud speaker. Automatic gain control is provided by a separate high-gain amplifier which receives its signal immediately before the detection process. This amplifier serves to keep the output of the receiver nearly constant in spite of a widely varying input signal strength and also to drive the panel signal strength meter. When signal strength permits, the automatic gain control amplifier may be switched out, allowing manual control.

TIME INTERVAL METERS

Beckman/Berkeley Time Interval Meters are precision timing instruments that use two separate input channels for starting and stopping timing action of the unit. Their time base generators produce uniformly separated pulses for accurately timing the interval between events.

A typical example of a Beckman/Berkeley Time Interval Meter is shown in the block diagram.



Input circuitry of both the start and stop channels shapes the incoming signals and feeds them to the gate. The gate is held open for the interval separating the start and stop pulses which arrive from the input channels. During this interval pulses from the clock pulse generator are passed through the gate and counted by the Decimal Counting Units. The reading registered by the DCUs represents the elapsed time between the start and stop signals.

Repeated measurements can be made automatically because of the self resetting and variable display time features of the time interval meters.

All of the time interval meters described in this catalog can be employed as straight counters, for making A/B (ratio) measurements, and Period and Time Interval measurements. The A/B function permits a direct reading of the ratio of two frequencies simultaneously appearing at the inputs. Period measurement permits highly accurate determination of low frequencies.

The time interval meter can be used whenever suitable signals representing the event to be timed or counted are available at the inputs of the counter. Appropriate transducers supply electrical signals to the counter. Separate input channels permit use of the time interval meter for timing relays, solenoids, and other controls whose action is initiated by a signal at one polarity and ended by a signal of the opposite polarity. Other applications include events counting, low frequency measurements, frequency ratio determinations, phase measurements, ballistics, elasticity, calibration of pulse generators, and timing flashes or dark periods.



Simple to operate and service, this moderately-priced portable instrument counts precise clock signals (100 microsecond separation, internally generated) for an interval of time determined by the externally applied signal. Model 5220 Time Interval Meter employs a 10 KC crystal controlled oscillator to generate the clock signal.

A function switch lets the operator select the desired function at will. Dual input channels, time base, and a gate followed by a series of DCUs make up the major components of this unit.

On the Count function the instrument behaves as a straight electronic counter, totalizing events applied to it.

In the Period function the instrument counts time base signals for a time determined by the external signals received on a common (single) input channel. The TIM function is similar to the Period function except start and stop signals are supplied on separate channels so that isolated events can start and stop the counter.

In the A/B function, the ratio of the higher frequency input (A) to a lower frequency input (B) is displayed. This measurement is possible because of the two independent input channels.

TIM applications include:

- Relay timing
- Viscosity measurements
- Timing photographic components
- Ballistics
- Elasticity measurements
- Timing light flashes or dark periods
- Other laboratory and industrial applications

Berkeley Data Files 111 and 112 will tell you about the many interesting and unique applications of these versatile instruments. Free copies may be obtained from any Berkeley representative or from the factory.

FEATURES

- Compact Design — Portable
- Printed Circuits
- Simplified Controls
- Ease of Servicing
- High Quality at Moderate Cost

SPECIFICATIONS	Model 5220
Functions	TIM, Per, Count, A/B
Count Capacity	Readout 4 digits
Range	
Time Interval	100 μ sec to 1 sec
Period	0-10 KC
Ratio	1 to 10 ⁴ from 0-100 KC
Time Base	100 μ sec
Accuracy	± 1 count $\pm$ osc. stability
Oscillator Stability	1 part in 10 ⁴ per day
Sensitivity	.025 volts rms
Input Impedance	1 megohm, direct
Trigger Slopes	Positive or negative
Input Circuit Controls	Trigger voltage adjustments having ranges of ± 5 volts
Self Test Facility	Check of all frequency dividers and decimal unit counters
Display Time	Adjustable from .05 to 5 seconds when on automatic reset, indefinite when on manual reset
Auxiliary Connections	
Frequency Jack	For introducing an external frequency
Power Requirements	105, 117, or 126 volts $\pm 10\%$, 50-60 cps, 120 watts (supplied wired for 117v.)
Dimensions	12" H x 8" W x 14" D
Shipping Weight	30 lbs. (approx.)
Price	\$475.00, F.O.B. Richmond, California

MODIFICATIONS

Modification B	Incorporates additional circuitry to extend time base by a factor of 10. Price: \$70.00
Modification E	Extinguishes DCU's during scaling. Price: \$65.00
Modification H	Standard transformer replaced by unit having two tapped primary windings allowing operation from 210, 222, or 231 volts $\pm 10\%$ in addition to the 105, 117, or 126 volt $\pm 10\%$ operation normally supplied. Frequency 50-60 cycles. Supplied wired for 222 volt $\pm 10\%$ operation with proper line fuses. Price: \$25.00
Modification P	Provides binary coded readout for driving Digital Recorder or Inline Readout. Price: \$30.00



FEATURES

- TEN MEGOHM INPUT IMPEDANCE, Direct or AC coupled
- BINARY-CODED OUTPUT information from all DCUs
- CAN BE USED AS SLAVE EPUT® METER
- PERFORMS FREQUENCY RATIO MEASUREMENTS

Displaying all results in direct digital form, Beckman/Berkeley Models 7250 and 7260 Time Interval Meters (TIM) consist of two input channels and a gate, followed by a series of DCUs. Input channels include step-attenuators as well as trigger level controls. Use of trigger level controls rather than gain controls allows adjustment of trigger levels to precise points on input signals. This insures accurate measurement of complex waveforms and provides discrimination against noise signals. A highly stable crystal controlled oscillator, followed by an ex-

act divider chain, provides precise timing signals to be counted.

A function switch lets the operator select the desired function at will. Besides the TIM function, these models offer Count, Period, and A/B (ratio), for greatly increased usefulness.

In the TIM function, components are so arranged that the input signal controls the time that the time base signal is counted. This function is useful for making low frequency measurements and other applications involving periodic functions with low repetition rates.

The Count function causes the instrument to act as a straight electronic counter, totalizing the events applied to it.

The Period function is similar to the TIM function except that both start and stop signals are received over the same channel. This allows increased accuracy because

only one trigger level adjustment is required, making trigger level matching of two channels unnecessary.

In the A/B function the ratio of the higher frequency input (A) to a lower frequency input (B) is displayed. This measurement is possible because of the two independent input channels.

Binary-coded output is available on a 40-pin connector at the rear of the instrument. This information will operate a Berkeley Digital Recorder, Model 1452, or several Berkeley In-Line Readouts, 5610 Series.

Some of the applications of TIM are:

Relay switch timing	Accurate low frequency measurements
Viscosity Measurements	Calibration of pulse generators
Timing of photographic components	Timing light flashes or dark periods
Ballistics	Precision phase measurements
Elasticity measurements	Frequency ratio measurements

Berkeley Data Files 111 and 112 will tell you other ways to use these versatile instruments. Free copies may be obtained from any Berkeley representative or on written request to the factory.

SPECIFICATIONS	Model 7250	Model 7260
Functions	TIM, Period, A/B, Count	
Range: (Sine wave or pulse) Time Interval or period	10 μ sec. to 1 sec.	1 μ sec to 1 sec.
Accuracy	10 μ sec. $\pm$ 1 part in 10^5	$\pm$ 1 μ sec $\pm$ 3 parts in 10^7 per week
External Standard Input	0-100 Kc, 3 volts rms.	0-1 MC, 3 volts rms.
Sensitivity (TIM or period)	0.1 V. rms.	
Input Impedance	10 Megohms, Direct — or AC — coupled	
Trigger Slopes	Positive or negative	
Input Circuits	Step Attenuators with Trigger Level Adjustments having ranges of $\pm$ 1, $\pm$ 10, and $\pm$ 100 volts	
Standardization	May be standardized against WWV or other external frequencies	
Display Time	Adjustable 0.1 to 10 seconds (automatic electronic reset). Display can be held indefinitely (manual reset)	
Printer Connection	Binary-coded output information from DCU's to operate Model 1452 Digital Printer or Series 1440 Data Converters	
Power Requirements	105, 117, or 126 volts, $\pm$ 10%, 50-60 cps (supplied wired for 117v.), Model 7250, 210 watts, 7260, 280 watts	
Dimensions	Cabinet Mount: 10½" H x 20¾" W x 16½" D. Rack Mount: 8¾" H x 19" W x 16" D	
Shipping Weight	Approx. 60 lbs.	
Price	Model 7250: \$695.00; Model 7260: \$925.00, F.O.B. Richmond, California	

MODIFICATIONS

Modification B	Provides an additional Decimal Counting Unit to increase time interval measurement range to 10 seconds. Permits averaging of period or frequency ratio measurements over 10 periods, and increases the count capacity by a factor of 10. Price: \$70.00
Modification C	Adds 4-digit mechanical register. Extends capacity by 10^4 counts when not combined with modification B. Price: \$80.00
Modification D (7250)	Adds temperature controlled crystal for greater stability. Crystal stability is $\pm$ 3 points in 10^6 per week. (Standard on Model 7260.) Price: \$30.00
Modification E	Extinguishes DCU's during scaling. Price: \$65.00
Modification G (7250)	Provides automatic time base scanning. Automatic operation obtained by the addition of a preset timer. Permits selection of precise time bases from 3 to 6 seconds. Operation, including recycling, is completely automatic. Price: \$130.00
Modification H	Standard transformer replaced by unit having two tapped primary windings allowing operation from 210, 222, or 231 volts $\pm$ 10% in addition to the 105, 117, or 126 volt $\pm$ 10% operation normally supplied. Frequency 50-60 cycles. Supplied wired for 222 volt $\pm$ 10% operation with proper line fuses. NOTE: Crystal oven is rewired to operate only when Power Switch is ON. Price: \$25.00
Modification J (7260)	Provides 2 mc B channel and higher frequency DCU's (711AH and 713AH instead of 707AH and 705AH) to extend upper range to 2 mc. Price: \$80.00
Modification K	Increases input sensitivity from 0.1 volts to 5 millivolts at 5 cps providing operation from flow meter transducers. Price: \$50.00
Modification R	Standard relay rack mounting (8¾" x 19" panel). Substitutes a protective cover in place of the cabinet. No extra charge on original order.
Modification T (7250)	Combined Modification V and modified time base giving 0.5 second instead of 1 second. Price: \$85.00
Modification V (7250)	Provides drive circuit for driving remote indicator, Model 1941 or 1941X. Price: \$50.00

FEATURES

- ACCURACY to ± 0.1 microsecond
- SEVEN DIGIT READOUT — Time Intervals to 10 seconds
- BINARY-CODED OUTPUT information from all DCUs
- SIMPLIFIED CONTROLS — operation easily learned by non-technical personnel.
- .1 MICROSECOND RESOLUTION — Time Interval Measurements to a minimum of .3 microseconds.



This easy-to-use Time Interval Meter measures elapsed time between two events to a maximum accuracy of ± 1 microsecond. Time intervals of .1 or 1 microseconds may be selected. Time intervals of 1 or 10 seconds may be displayed, depending upon the unit selected.

Model 7270 consists of two input channels, each equipped with a step attenuator and trigger level control in addition to a slope switch. This permits precise settings on the input waveform and discrimination against noise signals.

Accurate timing signals are available from a 1 mc oven stabilized, crystal controlled oscillator and frequency multiplier. Externally generated timing signals of up to 10 mc may also be used.

Time interval measurements are easily performed by selecting the proper function and introducing start and stop signals into the appropriate channels. Select the desired timing interval (.1 or 1 microseconds) and read the elapsed time directly from the seven DCUs in decimal fractions (again in .1 or 1 microsecond increments).

Period measurements are performed in a similar way except that both start and stop signals arrive on the same channel. A Period x10 function gives a 10-period average of the input signal.

Because of the two independent input channels, frequency ratio measurements may be performed. The higher frequency (A) is applied to the "A" channel and the lower frequency (B) is applied to the "B" channel. Decimal counting units then read the ratio of A to B. The A/B x10 function gives a ten ratio accumulation (divides the B frequency by 10) for greater accuracy.

Timing signals for external use and four line binary-coded information are available from all DCUs on a connector at the rear of the instrument.

A partial list of applications includes:

Accurate Low Frequency Measurements	Ballistics
Calibration of Pulse Generators	Viscosity
Precision Phase Measurements	Timing
Frequency Ratio Measurements	

Berkeley Data Files 111 and 112 will tell you other ways to use these versatile instruments. Free copies may be obtained from any Berkeley representative or on written request to the factory.

SPECIFICATIONS	Model 7270
Functions	PER, PER x 10, TIM, A/B, A/B x 10
Count Capacity	7 digits
Measurement Ranges	
Time Interval	0.3 μ sec to 10 sec
Period	0-3 mc
Ratio	1 to 10^7 from 0-3 mc
Time Bases	0.1 μ sec and 1 μ sec
Accuracy	± 1 count $\pm$ oscillator stability
Oscillator Stability	± 3 parts in 10^7 per week
Output Frequencies	1 mc and 10 mc
External Standard Input	0-1 mc, 3 volts rms
Sensitivity (all functions)	0.2 volt rms
Input Impedance	1 megohm, direct or a-c coupled
Trigger Slopes	Positive or Negative
Input Circuit Controls	Step-attenuators and trigger voltage adjustments having ranges of ± 1 , ± 10 and ± 100 volts
Standardization	May be standardized against WWV or other external frequencies
Display Time	Adjustable from 0.1 to 10 seconds when on automatic reset, indefinite when on manual reset
Auxiliary Connections	
Printer Connections	Binary coded information from the DCU's to operate a printer or other accessories.
Frequency Jack	For outside utilization of the internal frequency or introducing an external frequency
Power Requirements	105, 117, or 126 volts $\pm 10\%$, 50-60 cps (supplied wired for 117v.), 280 watts approx.
Dimensions	10 $\frac{1}{4}$ " H x 20 $\frac{3}{4}$ " W x 16 $\frac{1}{2}$ " D
Weight	60 lbs. (approx.)
Price	\$1675.00, F.O.B. Richmond, California

MODIFICATIONS

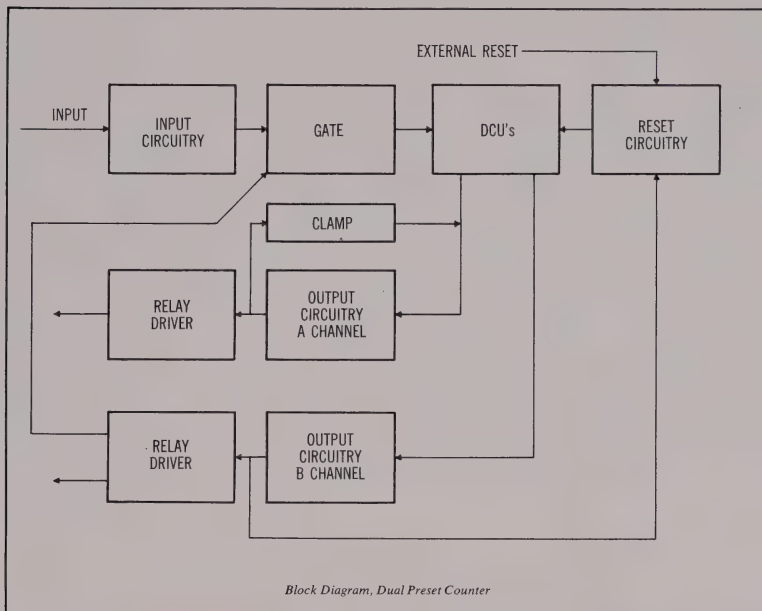
Modification C	Adds 4 digit mechanical register and associated drive circuit. Price: \$80.00
Modification H	Standard transformer replaced by unit having two tapped primary windings allowing operation from 210, 222, or 231 volts $\pm 10\%$ in addition to the 105, 117, or 126 volt $\pm 10\%$ operation normally supplied. Frequency 50-60 cycles. Supplied wired for 222 volt $\pm 10\%$ operation with proper line fuses. NOTE: Crystal oven is rewired to operate only when Power Switch is ON. Price: \$25.00
Modification R	Provides for relay rack mounting. No charge on original order.

PRESET COUNTERS

Beckman/Berkeley offers both single and dual preset counters for maximum flexibility at minimum cost. Output information at any count within the maximum capacity of the unit may be obtained.

Preset counters find wide application in industry as controllers. Single preset counters are used to measure quantity and activate control devices at a predetermined level. Dual preset counters are used where upper and lower limits are involved; for example, controlling speed within certain parameters.

Preset counters consist of an input circuit which feeds information to a gate and subsequently to the preset DCUs. No time base is used. Information from the preset number must control the gating action. The block diagram illustrates the source of gate control.



Block Diagram, Dual Preset Counter

The uses of preset counters fall into two general classifications, (1) where a single preset number will offer adequate control, and (2) where two limits are required. Beckman/Berkeley offers preset counters of both types and of sufficient range to cover virtually all applications.

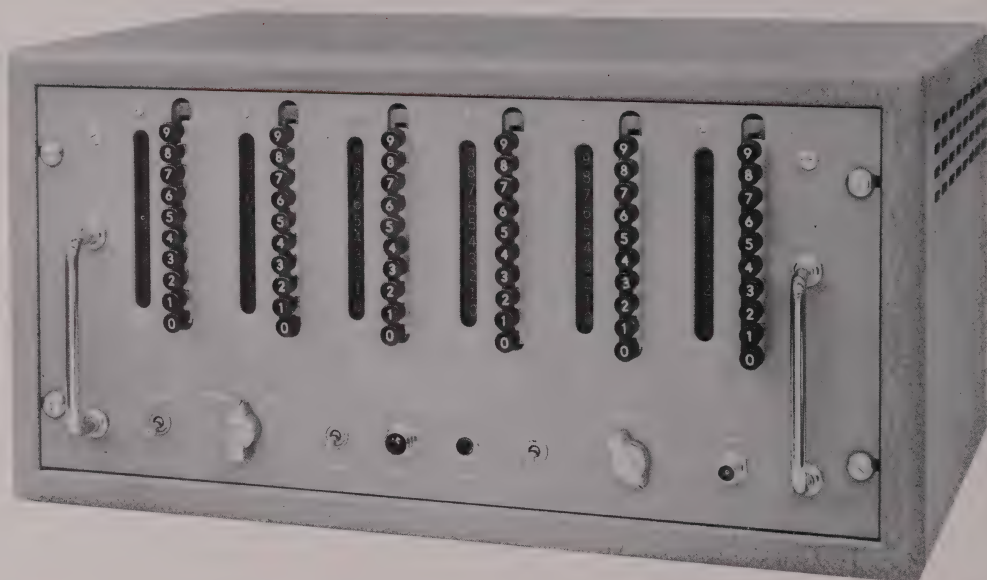
A typical application of a single preset counter is the use of the counter to control the filling of containers. When the flow starts, a suitable transducer supplies information to the counter. At the preset count, the counter produces an output which may be used to activate a solenoid, close a valve, etc. Then a new container is moved into position and the process repeated.

A dual preset counter may be used to control the speed of rotating machinery by producing signals to keep the speed within preselected limits. At speeds above the selected limit, the counter supplies a "decrease" signal to the motor controller. If the speed drops below a selected limit, the counter supplies the controller with an "increase" signal. This application requires a precise sampling period to be supplied to the preset counter. Modified, a "danger" signal may be rendered at the upper limit of speed and an "emergency stop" signal above it.

Beckman/Berkeley also manufactures a Magnetic Dual Preset Controller using Ferristors* instead of electron tubes. Ferristors* are non-aging, immune to shock, vibration, and moisture. They consist of simple wire-wound coils on a ferro-magnetic core and perform the functions of input amplifier, gate, time base, DCUs, coincidence amplifier, and control circuit.

For industrial applications, the magnetic controller offers several advantages. Long life with practically no "down time" is the principal feature. Low heat generation of the Ferristor* makes possible dust-proof enclosure, an important consideration in many industrial applications.

*T. M.



SPECIFICATIONS

Model Number	5422	5423	5424	5425	5426
Capacity	1-100	1-1000	1-10,000	1-100,000	1-1,000,000
Input Frequency	From DC to 40,000 cycles per second				
Input Sensitivity	± 1 volt peak with respect to ground, at least 2 μ seconds wide. Large amplitudes can be attenuated by front panel potentiometer.				
Input Impedance	1 megohm shunted by approximately 40 μ fd				
Output Information Choice of	1. PULSE: A 45 volt pulse between -35 and $+10$ volts with a rise time of 3 microseconds and fall time of 1 microsecond. Pulse width 12 microseconds 2. PULSE-RELAY: A positive pulse as above and internal relay actuation both with duration adjustable 0.03 to 0.25 seconds. Two Form C relay contacts are provided. 3. HOLD-RELAY: A voltage change between -35 and $+10$ volts and locking relay operation are available				
Power Requirements	117 volts, $\pm 10\%$. Wattage varies from 90 to 180 watts depending upon model number				
Front Panel Dimensions	15 $\frac{1}{8}$ " x 8 $\frac{3}{4}$ "		19" x 8 $\frac{3}{4}$ "		
Over-all Dimensions	16 $\frac{1}{8}$ " x 10 $\frac{1}{4}$ " x 13"			20 $\frac{3}{4}$ " x 10 $\frac{1}{2}$ " x 15"	
Price, F.O.B. Richmond, Calif.	\$435.00	\$500.00	\$595.00	\$660.00	\$740.00
Replacement Preset DCU	Modification A Millisecond Plug-In Relay \$25.00 Model 730A Preset Decimal Counting Unit \$70.00				

The single Preset Counter is a high speed electronic counter with provisions for obtaining output information at any count up to the maximum capacity of the unit. Any discrete physical change that can be converted into a changing voltage can be counted. This conversion can be accomplished through the use of various transducers such as photocells, magnetic pickups, switches or devices that provide a frequency output with suitable characteristics for operating the counter. The physical change can occur at rates from DC to 40,000 times per second, the maximum continuous counting rate of the Preset Decimal Counting Unit used in Berkeley Preset Counters. Pre-setting the counter is accomplished by depressing the desired push button in each column of digits. These are clearly numbered and opposite the corresponding number on the illuminated lucite panel of the Decimal Counting Unit.

The Preset Counter consists of an input circuit, an electronic gate, cascaded presettable Decimal Counting Units and output circuitry. Events to be counted are applied to the input, amplified, shaped and sent to the electronic gate. When this gate is opened the incoming count is passed to the first of the cascaded Preset Decimal Counting Units.

A Preset decade functions as an electronic scale of ten with each of the four binary stages connected to four triodes that are normally off. Selecting a preset count turns on certain triodes. These move to the non-conducting state when the preset number is reached. Since the plate load for the triodes of all Decimal Counting Units is common, a positive output is obtained at the preset count. The output of the coincidence circuit is applied to a triode inverter that is used to drive a one-shot multivibrator. The multivibrator is used to drive a plug-in relay and pulse output circuits.

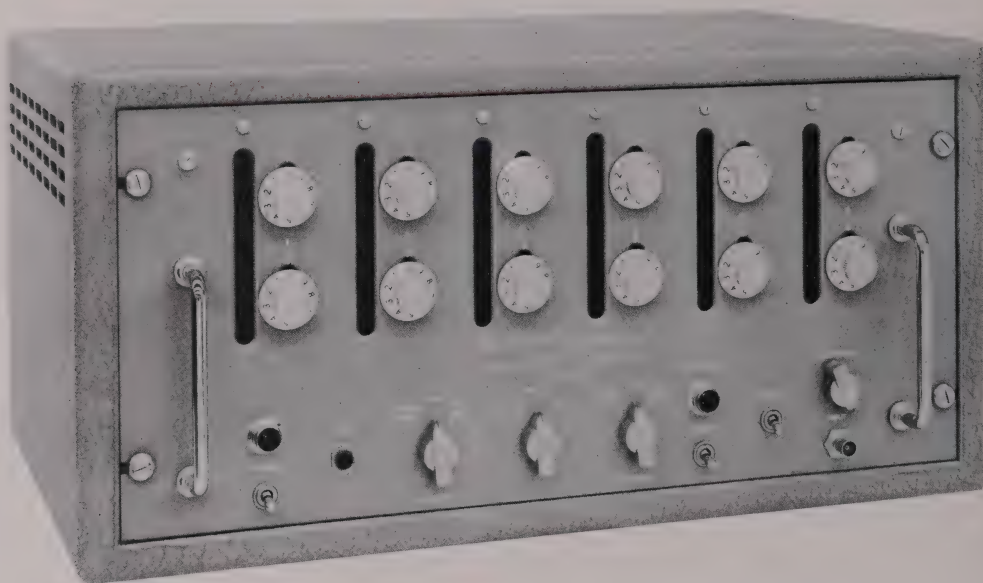
The Preset Counter performs any one of three functions, according to the position of the front panel switch. In the "counter" position, the instrument functions as a straightforward counter. Output information is obtained each time the full capacity of the unit is reached. In the "Recycle" position, the unit will count to the preset number, provide an output pulse, reset, and indefinitely repeat the cycle without losing a count. In the "Gate" position the unit counts to the preset number and continues counting input information after the preset number is reached. At the preset number an output voltage change and relay actuation are available. The state of the output information then remains unchanged until the unit is reset by manually depressing the "Reset" button or by applying a positive pulse to Pin D of the accessory socket.

The Model 730A Preset Decimal Counting Unit is used in preset counters. Design of the Model 730A reflects Berkeley's years of engineering skill and experience in providing plug-in sub-assemblies wherever practicable. Each unit is completely interchangeable with any other Model 730A Preset Decimal Counting Unit, thus simplifying replacement and maintenance problems.

Modification A provides for a high speed millisecond plug-in relay with single Form C contacts.

RELAY CONTACT RATINGS

	Standard Relay	Modification A Millisecond Relay
Maximum Open Circuit Voltage	500 volts	500 volts
Maximum Current	5 amps at 115 volts	5 amps
Maximum Power		250 V-A



The Dual Preset Counter, a high speed counting instrument, provides output information at any two counts within the maximum capacity of the unit. Any discrete physical change represented by a changing voltage can be counted. Various transducers such as photocells, magnetic pickups, switches, or other devices that provide a suitable voltage output are used to operate the counter. The physical change may occur at rates between DC and 40,000 times per second — the maximum continuous counting rate of the Preset Decimal Counting Units. Presetting the counter is accomplished by rotating the two switches adjacent to each decade. Because of its flexibility and simplicity of operation, this instrument is ideal as a production line control device. Output signals can be used to control many processes automatically or to sound an alarm prior to the second preset count.

APPLICATIONS

Control of counting, weighing, sorting, packaging, shearing, metal forming, coil winding equipment; cut-off

motors, turbines, jet engines at precise predetermined rev count or speed, computer timing, etc.

COIL WINDING

The Dual Preset Controller is ideally suited for control of high speed coil winding equipment. By use of a suitable pickup device, each turn added to the coil is registered as a count on the electronic control unit. When the first preset count is reached, the output information can be used to slow the coil winder so that when the second preset count is reached, there will be no overshoot due to the inertia of the winding unit.

AUTOMATIC PACKAGING

Because of its instantaneous clear to zero after reaching the preset count, the Dual Preset Controller is ideal as a continuous high speed packaging control unit. When used with the proper mechanical switching arrangement, this unit will give absolute accuracy. The double preset count allows the first count to be used as a warning signal before the final count. At warning, the operator can then prepare the equipment for the start of the next run.

SORTING TO LENGTH

Flat sheets of all types can be sorted so that lengths falling outside the desired value are rejected. In this case, linear length is converted into voltage pulses by a suitable transducer and a kicker is actuated if the length falls out of the desired limits.

MOTOR CONTROL

If the preset controller is used in combination with an electronic digital rpm indicator, it can be used to control motor speed between limits. In a similar manner, a combination such as this can be used to accurately control pressure temperature, frequency and many other phenomena.

DESCRIPTION

The Dual Preset Counter consists of an input circuit, an electronic gate, cascaded presettable Decimal Counting Units and two identical output channels. Events to be counted are applied to the input, amplified, shaped and applied to the electronic gate. When this gate opens, the incoming count is passed to the first of the cascaded Decimal Counting Units. At the first preset count, output information is derived from the first coincidence system and at the second preset count, the second coincidence system.

Each decade is an electronic scale-of-ten with two identical coincidence circuits. The decade scale is accom-

plished by incorporating feedback in a four stage binary scale of 16. The coincidence circuit is formed by four triodes with each triode connected to a binary stage of the decade. The corresponding group-of-four triode plates of all the Decimal Counting Units are connected to a common plate load to form a coincidence system. Similarly, the other group-of-four triode plates connect to another plate load to form the second system.

Each output channel consists of a triode inverter, diodes, a multivibrator and a relay drive circuit. Selection of a preset count turns on certain triodes in the system which cut off at the preset number. The common plate connection then rises in voltage, driving the multivibrator circuit and the relay circuit.

Three modes of operation determined by the position of the function switch are possible:

In the Counter position, the instrument is an electronic counter. An output occurs at the first or lower preset number and a second output at the full capacity of the unit.

In the Recycle position, outputs occur at both the first and second preset numbers. The second output resets the counter to zero and initiates a new cycle. Cycling may be continued indefinitely without losing a count.

In the Gate position, input pulses are gated off at the second preset number. Again, outputs are available at both preset numbers, but the second number is displayed until cleared by the Reset button or an external reset circuit.

Model Number	5442	5443	5444	5445	5446												
Capacity	1-100	1-1000	1-10,000	1-100,000	1-1,000,000												
Input Frequency	From DC to 40,000 cycles per second																
Input Sensitivity	± 1 volt peak with respect to ground, at least 2 microseconds wide. Large amplitudes can be attenuated by front panel potentiometer																
Input Impedance	1 megohm shunted by approximately 40 micro-microfarads																
Output Information	Control signals independently available at both channels																
Choice of	1. PULSE: A 45 volt pulse between —35 and +10 volts with a rise time of 3 microseconds and fall time of 1 microsecond. Duration adjustable from 12 to 150 microseconds. 2. PULSE-RELAY: A positive pulse as above and internal relay actuation both with duration adjustable 0.02 to 0.4 seconds. Form C relay contacts are provided. 3. HOLD-RELAY: A binary voltage between —35 and +10 volts and internal relay actuation are available. The relay in each channel is actuated with each change in state of binary. By selection, the binary in the first channel can change at first or at first and second preset counts. The binary in the second preset channel changes only at the second preset count. The relays are plug-in type with 2 sets of Form C contacts rated for a 5 amperes non-inductive load at 117 volts. High speed millisecond operating time relays with a single Form C contact arrangement are available as Modification A. Relay contact ratings: <table><tr><td></td><td>Modification A</td><td>Standard Relay</td></tr><tr><td>Maximum Open Circuit Volts</td><td>500 volts</td><td>500 volts</td></tr><tr><td>Maximum Current</td><td>5 amperes</td><td>5 amps @ 115 v, 602</td></tr><tr><td>Maximum Product, all cases</td><td>250 V-A</td><td></td></tr></table>						Modification A	Standard Relay	Maximum Open Circuit Volts	500 volts	500 volts	Maximum Current	5 amperes	5 amps @ 115 v, 602	Maximum Product, all cases	250 V-A	
	Modification A	Standard Relay															
Maximum Open Circuit Volts	500 volts	500 volts															
Maximum Current	5 amperes	5 amps @ 115 v, 602															
Maximum Product, all cases	250 V-A																
Power Requirements	117 volts, ± 10%. Wattage varies from approximately 160 to 250 watts depending upon model																
Front Panel Dimensions	19" x 8¾"																
Overall Dimensions	20¾" x 10½" x 15"																
Price	\$650.00	\$720.00	\$785.00	\$845.00	\$895.00												
	Modification A for millisecond relays \$40.00																
Replacement Preset DCU	Berkeley Model 732 Dual Preset Decimal Counting Unit			\$80.00 each													



SPECIFICATIONS

Model Number	5844	5845	5846
Capacity	1-9,999	1-99,999	1-999,999
Input Frequency	From DC to 8,000 cycles per second		
Input Sensitivity	100 microamperes		
Input Impedance	10,000 ohms in series with 60 millihenries		
Level Control Range	± 1 milliampere		
Output Information	Control signals available independently for both channels		
Accuracy	Absolute		
Operating modes	Manual or automatic, recycling at higher count		
Outputs Available	For each preset count and DPDT relay; may be either pulse (adjustable) or hold between successive counts		
Remote Reset	From external contact closure		
Supply Voltage	50-60 cps, switch selects taps at 105, 117, and 126 volts $\pm 10\%$ or 210, 222 and 231 volts $\pm 10\%$		
Power Requirements	117 volts, $\pm 10\%$. Wattage varies from approximately 60 to 85 depending upon model		
Dimensions	18 $\frac{1}{2}$ " wide by 8-23/32" high by 13 $\frac{1}{2}$ " deep overall, for standard relay rack or wall mounting		
Weight	50 lbs.		
Price	\$1115 (Model 5844), \$1200 (Model 5845), \$1295 (Model 5846)		

Replacement Preset DCU Berkeley Model 736 Dual Preset Decimal Counting Unit \$130.00 each

FEATURES

- Long Life
- Extreme Reliability
- Manual or Automatic Operation

Magnetic Dual Preset Controllers are designed primarily for industrial applications where long, trouble-free life is of prime importance.

Ferristors*, miniature saturable reactors are used to replace electron tubes as input amplifier, gate, time base, DCU, coincidence amplifier, and control circuits.

The controller consists of an input circuit, cascaded presettable Decimal Counting Units and two identical output channels. Events to be counted are applied to the input, amplified, and shaped. The incoming count is passed to the first of the cascaded Decimal Counting Units. At the first preset count, output information is derived from the first coincidence system and at the second preset count, from the second coincidence system. The decade counter used in the controller, a magnetic ring-of-ten, utilizes the ferro-resonant counting principle.

Each output from the coincidence gate amplifiers is connected to a magnetic amplifier which drives a double pole-double throw relay. With proper feed back elements this amplifier performs as a one-shot or flip-flop, thus giving either momentary or holding closure of relay contacts.

Two modes of operation are possible: Manual and Automatic. Used manually, the controller gives the desired outputs at the preset numbers but must be manually instructed to repeat the cycle of operation. Used automatically, the controller gives the desired outputs at the preset numbers, resets itself to zero at the second number, and repeats the cycle indefinitely.

APPLICATIONS

Control of counting, weighing, sorting, packaging, shearing, metal forming, coil winding equipment; cut-off

motors, turbines, jet engines at precise predetermined rev count or speed, computer timing, etc.

COIL WINDING

The Dual Preset Controller is ideally suited for control of high speed coil winding equipment. By use of a suitable pickup device, each turn added to the coil is registered as a count on the electronic control unit. When the first preset count is reached, the output information can be used to slow the coil winder so that when the second preset count is reached, there will be no overshoot due to the inertia of the winding unit.

AUTOMATIC PACKAGING

Because of its instantaneous clear to zero after reaching the preset count, the Dual Preset Controller is ideal as a continuous high speed packaging control unit. When used with the proper mechanical switching arrangement, this unit will give absolute accuracy. The double preset count allows the first count to be used as a warning signal before the final count. At warning, the operator can then prepare the equipment for the start of the next run.

SORTING TO LENGTH

Flat sheets of all types can be sorted so that lengths falling outside the desired value are rejected. In this case, linear length is converted into voltage pulses by a suitable transducer and a kicker is actuated if the length falls out of the desired limits.

MOTOR CONTROL

If the preset controller is used in combination with an electronic digital rpm indicator, it can be used to control motor speed between limits. In a similar manner, a combination such as this can be used to accurately control pressure temperature, frequency and many other phenomena.

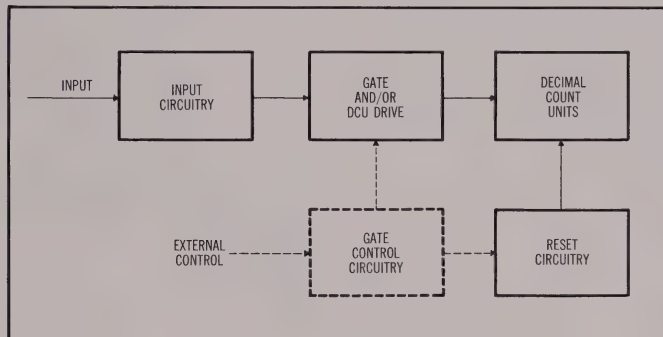
This is but a partial list of applications for the Magnetic Dual Preset Controller. We invite your inquiries concerning specific applications.

ELECTRONIC COUNTERS

Beckman/Berkeley manufactures four basic electronic counters to satisfy a wide range of counting needs. These moderately priced counters offer a convenient means of counting at speeds well above the range of mechanical counters.

Electronic counting has many advantages. High speed counting rates up to 1 million per second may easily be achieved. Electronic counters may be activated with a large variety of transducers, many containing no moving parts.

Two of the electronic counters are of the "straight counter" type, that is, they are not gated off or on. Models 5001 and 5010 are of this type. Models 7050 and 7060 are "gated" counters. In a "gated" counter, counting time is controlled by external signals. The block diagram shows an electronic counter. the gate control is indicated by the broken block.



Electronic counters may be used for counting events occurring at either regular or random rates as long as minimum separation is within the resolution time of the counter.

Counting rates of 125 cps, 10,000 cps, 100,000 cps and 1 million events per second may be counted.

Applications for Beckman/Berkeley counters are found in numerous industrial applications. Manufacturing processes such as counting cans or steel sheets without employing mechanical contact are typical. Electronic counters may be employed for counting shaft revolutions with or without mechanical connection by using transducers manufactured for this purpose. Relay timing, viscosity and ballistic measurements are among the other applications.



Model 5010



Model 5001

SPECIFICATIONS	Model 5001	Model 5010
Resolution	Will resolve pulses of greater than 20 microseconds separation	
Counting Rate	0-125 counts per second	0-10,000 counts per second
Count Indication	Direct Reading	
Input Pulse Requirements	Positive voltage 1v., noise less than .1 volt peak to peak	
Input Impedance	800 K ohms shunted by 250 μ fd	800 K ohms
Power Requirements	105-125 volts-50-60 cycles, 35 watts	105-125 volts-50-60 cycles, 75 watts
Dimensions	6½" x 10½" x 8"	14¼" x 10½" x 9¾"
Panel Size	6½" x 10½"	8" x 13"
Weight	11 lbs.	35 lbs.
Prices	\$195.00	\$330.00
with 2 DCU's		\$315.00
less Mech. Reg.		\$315.00

Model 5001 is rugged, industrial type electronic counter which will operate reliably under mechanical abuse, to speeds up to 125-counts per second. This provides a solution to counting problems where speed requirements are in excess of the limitations of mechanical registers (10 per second), but not great enough to warrant more extensive electronic installations. All circuits have been developed around one tube type, the 5963, in order to facilitate servicing. The totalized count is displayed on the Decimal Counting Unit and the register. The total indicating capacity of the Model 5001 is 9,999,999 counts, Maximum pulse-pair resolution time is 20 microseconds, hence deviations in counting rate do not affect the absolute accuracy of the instrument.

Additional features include: A 3:1 and 10:1 attenuator on the input channel which reduces sensitivity of input to "hash" when the input pulse is riding on a -2 to $+10$ volt DC voltage. A preset mechanical register can be substituted on special order to give output switch closures from 10 to 10,000,000 counts. Contacts are rated for 115 volts AC, 2 amps, non-inductive. The Decimal Counting Unit is not presettable. Supplied with special industrial cabinet with plastic tamper-proof cover and latching hasp. Closing Contacts: A source of potential is available in the rear of the instrument to be used with closing contacts. Photocell: The same source of potential is available for photocell use and is sufficient to operate a variety of photocells. Voltage Pulse: Whenever a positive potential of .5 volts or greater is applied to the grid terminal of the counter, the decimal counting unit will register one count. The acceptance of the pulse is not dependent upon the rate of rise of the applied potential. Therefore, a slowly varying voltage will trigger the unit as readily as a voltage pulse of a few microseconds duration.

This is a high-speed electronic counting instrument designed to fill general counting needs, where speed requirements are greatly in excess of those possible with mechanical counters.

Any occurrence which can be made to actuate mechanical, electrical, or optical devices, can be counted with absolute accuracy over a range of 0 to 10,000 counts per second. It will count random or regularly

occurring events with equal facility; therefore, fluctuations in counting rate have no effect on the actual total count.

The unit is composed of a power supply, input amplifier, pulse-former, three Berkeley Decimal Counting Units, an electronic relay, and a mechanical register.

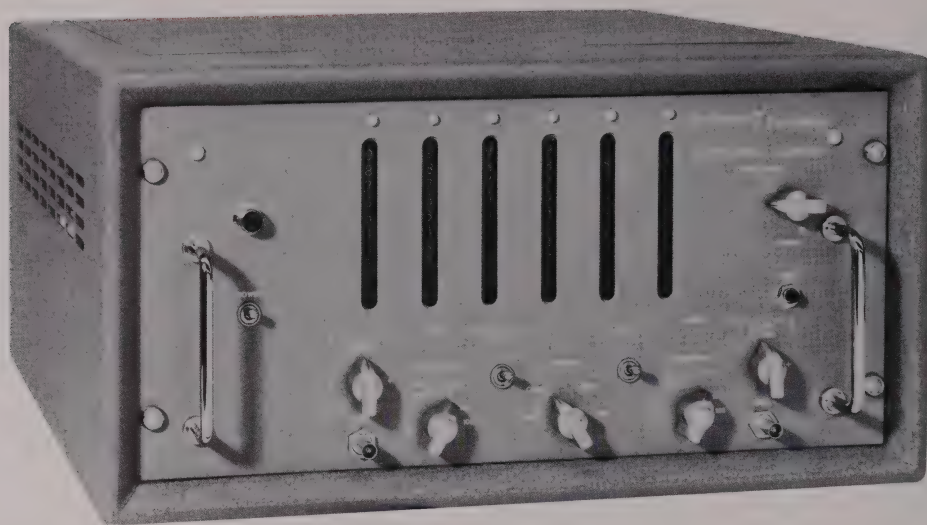
The first 999 events are read directly on the illuminated panels of the Decimal Counting Units. The last decade actuates the six-digit mechanical register extending the range of the instrument to 10^9 counts.

Model 5010 can be supplied on special order with two Decimal Counting Units in place of the standard three, and less the mechanical register if desired. Since the maximum counting rate is not determined by the electronic components, but rather by the capabilities of the mechanical register (10 per second), the maximum counting rate of the instrument is 1000 per second with two decade units and 10,000 per second with three decade units, the standard model.

In the investigation of the characteristics of electric motors, turbines, jet engines, etc., much useful information can be obtained by counting precisely the number of revolutions after the motive power has been removed. Also in many industries such as textiles and machine tool design, it may be desirable to know the total number of revolutions of a high speed shaft. Model 5001 or 5010 is ideally suited to these measurements when used with a suitable pick-up device such as a cam-operated switch, an induction generator, a lightsource-chopper disc, photocell or a vibration pick-up. Each revolution of the shaft is counted and the total is indicated directly on the front panel. If greater accuracy is required the signal generator can be arranged to generate multiple signals per revolution.

Manufactured or processed items moving on a conveyor belt, chain or chute may be counted automatically at rates far in excess of those possible with a mechanical counter. The pick-up device may be mechanical, electrical, photocell and light source, or inductive circuit. These devices provide the flexibility necessary to meet the particular requirements of any given situation.

Additional applications are suggested in Data Files 111 and 112, available upon request.



FEATURES

- Manual or Electronic Gating
- Ten Megohm Input Impedance, Direct or AC coupled
- Binary-coded Output from all DCUs
- Functions as Slave EPUT[®] Meter
- Adjustable Input Trigger Levels

Models 7050 and 7060 are versatile electronic gated counters. Each consists of an input channel, controllable gate and a series of DCUs. Measurements are displayed in direct digital form. A function control allows gate control from manual off-on switch and from start-stop signals applied to one of the two input channels (the input jack located on the rear of the instrument then receives the signal under count). Input amplifiers are identical; each has a step attenuator and trigger level control providing ranges of ± 1 , ± 10 , and ± 100 volts.

Use of trigger lever controls rather than gain controls allows adjustment of start and stop levels to precise points of input signals. This provides accurate measurement of complex waveforms and discrimination against noise signals.

Using the manual reset, the counter accumulates counts with the manual "off-on" switch in the "on" position. Used with the Model 1452 Digital Recorder, an automatic printed record is obtained each time the switch is returned to the "off" position.

Using electronic gate control, the instrument reads out each time a "stop" signal is received. By making a simple internal wiring change, the instrument is a cumulative counter. When electronic gate control is used, the signal under count is applied to the rear input channel.

Binary-coded output information is available at a 40-pin connector at the rear of the instrument. This informa-

tion will operate the Model 1452 Digital Recorder, and Series 5910 In-line Readouts.

Models 7050 and 7060 may be used as frequency ratio meters by indicating the ratio of two frequencies applied to the front input channels. Because of their short paired pulse resolution time, these counters may be used as nuclear counters, especially where printed records are desired or remote observation required. Digital phase measurements are another special application

of these instruments because of their ability to act as slave time interval and EPUT® Meters. One or more of these instruments may be connected in tandem to serve as slave EPUT® Meters, deriving their timing signals from an external source. Slave time interval meter usage also requires an external source of timing signals.

Additional applications are suggested by Data Files 111 and 112.

SPECIFICATIONS	Model 7050	Model 7060
Functions	Count, Gate, A/B	
Frequency Range	0 cps to 100 KC	0 cps to 1 MC.
Count Capacity	Readout five digits	Readout six digits
Sensitivity	0.1 volts rms.	
Input Impedance	10 Megohms, Direct — or AC — coupled	
Trigger Slopes	Positive or Negative	
Input Circuits	Step attenuators with trigger level adjustments having ranges of ± 1 , ± 10 and ± 100 volts	
Display Time	Adjustable 0.1 to 10 seconds (automatic electronic reset). Display can be held indefinitely (manual reset).	
Printer Connection	Binary coded output information from DCU's to operate Model 1452 Digital Printer, Series 1440 Data Converters, Series 5910 Inline Readout accessories, etc.	
Power Requirements	105, 117, or 126 volts, $\pm 10\%$, 50-60 cps, approx. 200 watts. (Factory wired for 117v.)	
Dimensions	Cabinet Mount: 10 $\frac{1}{4}$ " H x 20 $\frac{3}{4}$ " W x 16 $\frac{1}{2}$ " D. Rack Mount: 8 $\frac{3}{4}$ " H x 19" W x 16" D	
Shipping Weight	Approx. 60 lbs.	
Price	Model 7050: \$545.00; Model 7060: \$645.00, F.O.B. Richmond, California	

MODIFICATIONS

Modification C	Adds 4-digit mechanical register. Extends capacity by 10^4 counts. Price: \$80.00
Modification E	Extinguishes DCU's during scaling. Price: \$65.00
Modification H	Standard transformer replaced by unit having two tapped primary windings allowing operation from 210, 222, or 231 volts $\pm 10\%$ in addition to the 105, 117, or 126 volt $\pm 10\%$ operation normally supplied. Frequency 50-60 cycles. Supplied wired for 222 volt $\pm 10\%$ operation with proper line fuses. Price: \$25.00
Modification J (7060 only)	1 MC and first 100 KC Decimal Counting Units replaced by 2MC and 200 KC units, respectively. B input channel replaced by 2 MC unit. Especially useful for digital phase measurements to 0.1° at 400 cps. Price: \$80.00
Modification K	Increases input sensitivity from 0.1 volts to 5 millivolts at 5 cps providing operation from flow meter transducers. Price: \$50.00
Modification R	Standard relay rack mounting (8 $\frac{3}{4}$ " x 19" panel). Substitutes a protective cover in place of the cabinet. No extra charge on original order.
Modification V	Provides drive circuitry for driving remote indicator, Model 1941 or 1941X. Price: \$50.00



FEATURES:

- Binary-coded output information from all DCUs
- Paired Pulse Resolution of 1 microsecond
- Differential Pulse Height Analyzer
- Preset Count
- Electronic Counting and Timing

Model 2025

Beckman/Berkeley's Printing Scaler counts electronically and prints out count information automatically — two important features exclusive with this instrument. The Printing Scaler was specifically designed for use with an electronic timer to provide greatly increased accuracy (1/60th second as opposed to 0.2 second for a good mechanical timer). Joined to a recorder capable of handling binary coded information, the Printing Scaler counts, displays, prints results, resets itself, and begins counting again automatically.

DESCRIPTION

The Printing Scaler consists of a single channel differential pulse-height discriminator, electronic scaling circuit, count control circuit, and main power supply. Integral amplifiers can be included if desired. The discriminators and window amplifier of the Analyzer Section offer one microsecond or better resolving time for paired pulses.

The 5-turn channel position control features a 500 division Helipot Duodial and dial lock covering the range from 2 to 52 volts. A 4-position channel with switch selects either a 1, 2, or 5 volt window or infinity if integral operation is desired.

The Model 2025 incorporates a predetermined count selector for counting from 100 to 4,000,000 counts in 1-2-4 steps. Count control circuitry permits either manual or automatic counting and remote start-stop and reset.

Input Amplifier

Modification A gives an input sensitivity of 100 millivolts with high input impedance for G-M tube or scintillation counter use. Modification B increases the sensitivity to 500 microvolts. A nine-step attenuator is provided at the input to the amplifier. The attenuator has an impedance of 3,000 ohms and connects directly to the amplifier input connector. Because of the low impedance unit, a separate cathode follower preamplifier, Model 920A, is available. Both units are non-overloading linear amplifiers and use the long-tailed pair feedback amplifier design similar to that of Chase and Higinbotham (Rev. Sci. Inst. 23, 24 1952). Therefore, it is possible to count millivolt pulses following large overloading pulses (5 volts or greater) without blocking or causing unwanted base-line distortions. The rise time of the two amplifiers together is 0.35 microseconds. Incorporation of a fairly short time constant between amplifiers results in low noise output.

Model 811 Electronic Timer

The Model 811 electronic timer consists of two electronic dividers and five glow transfer tubes for counting line frequency in seconds or minutes. The control switch selects time in 1-3 steps from 0 to 10,000 seconds or 0 to 1,000 minutes. The timer is electronically gated from the scaler by a D.C. bias change on the first divider and first glow transfer driver tube. The Model 811 comes in a separate cabinet or a protective dust cover suitable for rack mounting.

Model 920A Preamplifier

The Model 2025 printing scaler with Modification B has a low input impedance of 3000 ohms with D.C. coupling. The low input impedance is a desirable feature if the detector is located at a remote position and the signal level is low. Use of a cathode follower preamplifier at the detector allows proper transmission line matching and reduces the possibility of spurious pulse pick up.

The Model 920A cathode follower preamplifier is available for this purpose.

SPECIFICATIONS Model 2025 Printing Scaler

INPUT CIRCUIT

Pulse height analyzer with range ± 2 to ± 52 volts. Windows: 1, 2, or 5 volts

- (a) Window width stability: 1% for the 2 volt window
- (b) Threshold stability: about 100 millivolts
- (c) Paired pulse resolution: Better than 1 μ sec

SCALING CIRCUIT

- (a) Six DCUs with 10^6 count storage capacity
- (b) Paired pulse resolution: Better than 1 μ sec

INTEGRAL AMPLIFIERS — Modification A

- (a) Input pulse polarity: Negative
- (b) Input sensitivity: 100 millivolts
- (c) Input impedance: A.C. coupled — 1 megohm shunted by 4 μ fd
- (d) Gain: X25
- (e) Rise Time: 0.2 μ sec
- (f) Maximum linear output: 50 volts
- (g) Saturated output: 100 volts
- (h) Paired pulse resolution: 1 μ sec
- (i) Dynamic range, 50:1

Modification B

- (a) Input pulse polarity: Negative
- (b) Input sensitivity: Approximately 500 μ volts
- (c) Input impedance: DC coupled, 3000 ohms
- (d) Gain: Approximately 5000
- (e) Rise time: .35 μ sec
- (f) Paired pulse resolution: 2 μ sec (with .25 μ sec clipping RC at output of detector)
- (h) Recovery time for overload pulse: 30 μ sec maximum
- (i) Maximum linear output: 50 volts
- (j) Saturated output: 100 volts
- (k) Dynamic range, 5000:1
- (l) Low impedance input attenuator
 - (1) Range: 500:1
 - (2) Steps: X1, X2, X5, X10, X20, X50, X100, X200, X500

CONTROLS

- (a) Momentary push button manual start, stop and reset
- (b) Automatic reset; automatic start—will start automatically after display and reset
- (c) Variable time display — zero to infinity
- (d) Channel width
- (e) Threshold level adjust
- (f) Input attenuator switch with modification B
- (g) Preset count selector — 100 to 4 million in 1-2-4 steps
- (h) Test-Operate

CONNECTORS & SOCKETS

- (a) Remote control socket — use with Model 620 automatic sample changer or external synchronous motor timer such as Microflex B212
- (b) Model 811 Electronic timer socket
- (c) Printer socket — Binary coded output information from DCUs to operate Model 1452 Digital Printer Series 1440 Data Converters, Series 5910 Inline Readout accessories, etc.
- (d) BNC amplifier input connector
- (e) BNC count-rate meter output connector
- (f) Power receptacle
- (g) BNC discriminator input connector
- (h) Preamplifier power supply connector

CHASSIS: 8 $\frac{3}{4}$ " high by 19" wide by 17" deep

NET WEIGHT: 70 lbs.

POWER REQUIREMENTS: 117 volts $\pm 10\%$, 50-60 cycles, 225 watts

OPTIONAL FEATURES: 4-digit Sedeco register — will not print out

PRICE: Model 2025 Basic Unit — 2 volt input sensitivity with preset count, F.O.B. Richmond, California\$850.00

Modification A 200 millivolt input sensitivity\$100.00

Modification B 1 millivolt input sensitivity\$200.00

Modification R Less cabinet with protective cover for standard relay rack mounting No charge

NOTE: High voltage supply available in two ranges, 2000 or 5000 volts. Separate units, cabinet or rack mounted

DECIMAL COUNTING UNITS

Beckman/Berkeley Decimal Count Units (DCUs) are the recognized standard of the electronics industry. Beckman/Berkeley's leadership was demonstrated early in the manufacture of DCUs and has been firmly maintained through the years.

There are three general groups of DCUs—straightforward, preset, and magnetic. Both straightforward and preset types are offered in magnetic DCUs. Straightforward DCUs are offered for counting a wide range of frequencies and preset DCUs for both single and dual output channels. Magnetic DCUs use miniature saturable reactors rather than electron tubes for long-life, reliability and ruggedness.

A DCU counts from 0 to 9 continuously, presenting an illuminated reading on the front panel. No interpolation is necessary. Simultaneously, the tenth pulse causes the DCU to recycle and produce an output pulse used to drive the next decade or other device. Momentarily opening the grid return or pulsing the next line with a positive voltage resets the DCU. An electronic counter of any capacity may be obtained by cascading the appropriate number of DCUs.

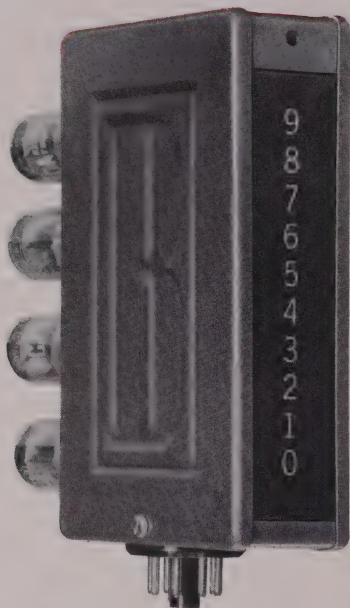
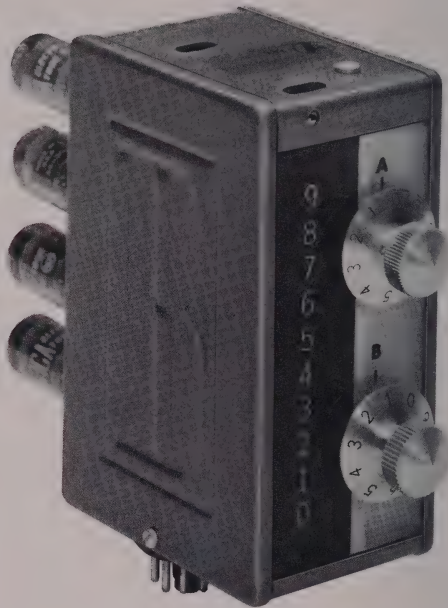
An example of the straightforward DCUs is the Model 705A. These units are constructed as plug-in units and consist of a frame supporting the tube sockets and a plastic "Craigmount." The individual components are inserted in the craigmount and firmly secured by their leads. This increases the reliability of the assembly by reducing complexity. Minimum lead length also aids operation and facilitates repairs when necessary. The circuitry consists of four binaries connected in cascade with feed back loops between the fourth and third stages and between the third and second stages. This permutes a scale of sixteen to a scale of ten. The binaries normally count to four. On the count of four the third stage feeds back into the second, which is the equivalent of adding two pulses to the input. On the count of six, the fourth stage feeds back to the third which is the equivalent of adding four more pulses to the input. By adding six pulses internally, the scale of sixteen has been converted to a scale of ten. The other straightforward models have feed back loops that differ from the Model 705A but accomplish the same thing.

Preset DCUs (Model 730A Single, and Model 732 Dual) are similar to the straightforward DCU except that additional selection and coincidence circuitry has been added. Output information to the coincidence amplifiers is taken from the plates of the binaries by means of four resistor-divider networks terminated in a negative voltage. Each divider is adjusted so that if the resistor connected to the negative supply is shorted, the amplifier tube associated with that divider network will be cut-off at all times.

The switch associated with the preset number is open, removing the short and permitting the grid of the coincidence tube to follow the plate of the binary to which it is connected. For example, removing the short from the resistor-divider network connected to one of the plates of the first binary turns the coincidence amplifier on and off as the first binary "flips" from the first state to the second state. Because the plates, as well as the cathodes, of all coincidence amplifiers are connected together, coincidence will be obtained only when all tubes are cut off.

If any number other than zero is selected with the unit reset to zero, at least one of the coincidence amplifiers will be conducting. As the count progresses, the number of tubes conducting will vary so that when the preset number is reached, all coincidence tubes are cut off and a large positive transient is produced.

Magnetic DCU circuitry consists of a ring-of-ten type counters using ten ferro-resonant bi-stable elements. Addition of gating circuitry provides a method of obtaining outputs at preselected counts.

**Model 705A****Model 732****Model 705A**

The Model 705A is a straightforward DCU capable of counting 100,000 pulses per second with a paired pulse resolution of 5 microseconds. Neon glow tubes light one of ten neon lamps placed behind a numbered acetate panel on each count. Power requirements are low and not critical. Pulses required to drive the DCU may be obtained from the output of preceding DCUs or pulse forming circuitry. This DCU produces an output pulse suitable for driving other 705A DCUs or Models 730A and 732. Modifications of the basic 705A are the 705AH and the 705AK. These models generate a binary coded decimal readout and are identical to the 705A in other respects. This code is in the form of high or low voltages at each of four pins on the DCU plug. They require 11 pin sockets.

Model 706A

The Model 706A is similar in construction to the 705A but is quite different in operation. It has a maximum counting rate of 350,000 counts per second with a paired pulse resolution of 1 microsecond. The increased counting speed is obtained by using circuitry employing input and clamping diodes. The diodes perform the feedback functions in permuting the scale-of-16 to a scale-of-10. The DCU produces an output capable of driving the Model 705A DCU.

Model 707A

The Model 707A employs more complex circuitry than the 706A and has a maximum counting rate of 1,000,000 pulses per second with a paired pulse resolution of 0.8 microseconds. The 707A produces an output capable of

driving the 705A, 730A and 732. The 707AH and 707 AK produce binary-coded output information.

Model 730A

The Model 730A Single Preset DCU has added coincidence circuitry in order to obtain output information at any preselected number except "0", when it behaves as a conventional DCU. Push buttons are provided for selecting the preset number. A description of the coincidence circuitry appears in the general discussion of

Decimal Count Units at the beginning of this section. The maximum counting speed of preset DCUs is 40,000 pulses per second.

Model 732

This DCU is provided with additional coincidence circuitry in order to allow two preset numbers to be selected and to provide two separate outputs. The operation is similar to the single preset DCU except that rotary switches are used instead of push buttons.

SPECIFICATIONS	705A	706A	707A	730A	732
Input Requirements	—pulse 100v peak	—pulse 140v peak	—pulse, 75v peak-w/r to DCU B+	—pulse 90v peak	—pulse 90v peak
Rise Time Duration	1 μ sec. at least 2 μ sec.	0.1 μ sec. at least 0.2 μ sec.	0.15 μ sec. at least 0.3 μ sec.	1 μ sec. at least 2 μ sec.	1 μ sec. at least 2 μ sec.
Paired Pulse Resolution	5 μ sec.	1 μ sec.	0.8 μ sec.	5 μ sec.	5 μ sec.
Maximum Counting Rate	100,000 cps	350,000 cps	1,000,000 cps	40,000 cps	40,000 cps
Filament Voltage	6.3v @ 1.2a $\pm 20\%$	6.3v @ 1.5a $\pm 10\%$ 6.3v @ 1.2a $\pm 10\%$	6.3v @ 3.6a $\pm 10\%$ 6.3v @ 1.8a $\pm 10\%$	6.3v @ 2.1a $\pm 10\%$	6.3v @ 3a $\pm 10\%$
Plates	225 to 400v (nominal 300 @ 13ma)	250 to 350v (nominal 300 @ 25ma)	175 to 275v (nominal 225 @ 60ma)	250 to 350v (nominal 300 @ 18ma) —150v @ 1ma	250 to 350v (nominal 300 @ 18ma) —150v @ 1ma
Reset to Zero	Instantaneous through opening of grid return or positive pulse 60-80 volts			Instantaneous through opening of grid return or positive pulse 60 to 80 volts	
Output Characteristics	Designed to drive 705A, 730A or 732	Designed to drive 705A,	Designed to drive 705A, 730A, 732	Designed to drive following: 705A, 730A or 732	
Count Indicator	Direct Reading Decimal Presentation				
Tubes	4 type 5963	4 type 5963 5 type 6AL5	4 type 5687 6 type 6AL5	4 type 5963 2 type 5964	4 type 5963 4 type 5964
Connector	Octal Socket				
Dimensions	1 $\frac{3}{8}$ " x 5 $\frac{1}{2}$ " x 5 $\frac{1}{2}$ " 1 lb.	2 $\frac{1}{2}$ " x 5 $\frac{1}{2}$ " x 5 $\frac{1}{2}$ " 1 lb.	3 $\frac{1}{4}$ " x 5 $\frac{1}{2}$ " x 5 $\frac{1}{2}$ " 2 lbs.	2 $\frac{1}{2}$ " x 5 $\frac{1}{2}$ " x 5 $\frac{1}{2}$ " 2 lbs.	2 $\frac{1}{2}$ " x 5 $\frac{1}{2}$ " x 5 $\frac{1}{2}$ " 2 lbs.
Price	\$35.00	\$65.00	\$95.00	\$70.00	\$80.00



SPECIFICATIONS	Models 716 - 717	Model 736
Power Input	165V rms $\pm 10\%$ @ 1.7 mc 1.5 watts per DCU Bias 300V @ 2 ma $\pm 10\%$	14V rms $\pm 10\%$ @ 1.7 mc 1.5 watts per decade
Pulse Input	20 ma peak Duration = 2 to 12 μ sec. Rise time = 5 μ sec. or better	20 ma peak Duration = 2 to 12 μ sec. Rise time = 5 μ sec. or better
Output Characteristics	$\pm 30V$ Max. output current = 3 ma Rise time = 5 μ sec. approx.	$\pm 30V$; maximum output current = 2 ma Rise time = 5 μ sec. approx.
Count Indication	Direct reading decimal presentation	Direct reading decimal presentation
Max. Count. Rate	Model 716 — 10,000 cps Model 717 — 40,000 cps	10,000 cps
Resolution of Paired Pulses	Model 716 — 100 μ sec. Model 717 — 25 μ sec.	100 μ sec.
Reset to Zero	+20V $\pm 20\%$ into 4,000 ohms Duration 40 μ sec.	+20V $\pm 20\%$ into 4,000 ohms Duration 40 μ sec.
Connector	Standard Octal Plug	Standard Octal Plug
Dimensions	1 $\frac{1}{8}$ " x 5 $\frac{1}{2}$ " x 3 $\frac{1}{2}$ "	1 $\frac{1}{8}$ " x 5 $\frac{1}{2}$ " x 3 $\frac{1}{2}$ "
Weight	13 oz.	1 lb.
Tubes	None	None
Price	\$110.00	\$130.00

Models 716, 717 and 736 Magnetic DCUs are long life, direct reading, highspeed counting devices using tiny magnetic amplifiers (Ferristors*) as the basic component rather than vacuum tubes. They were designed for industrial counting and control applications requiring the utmost in reliability.

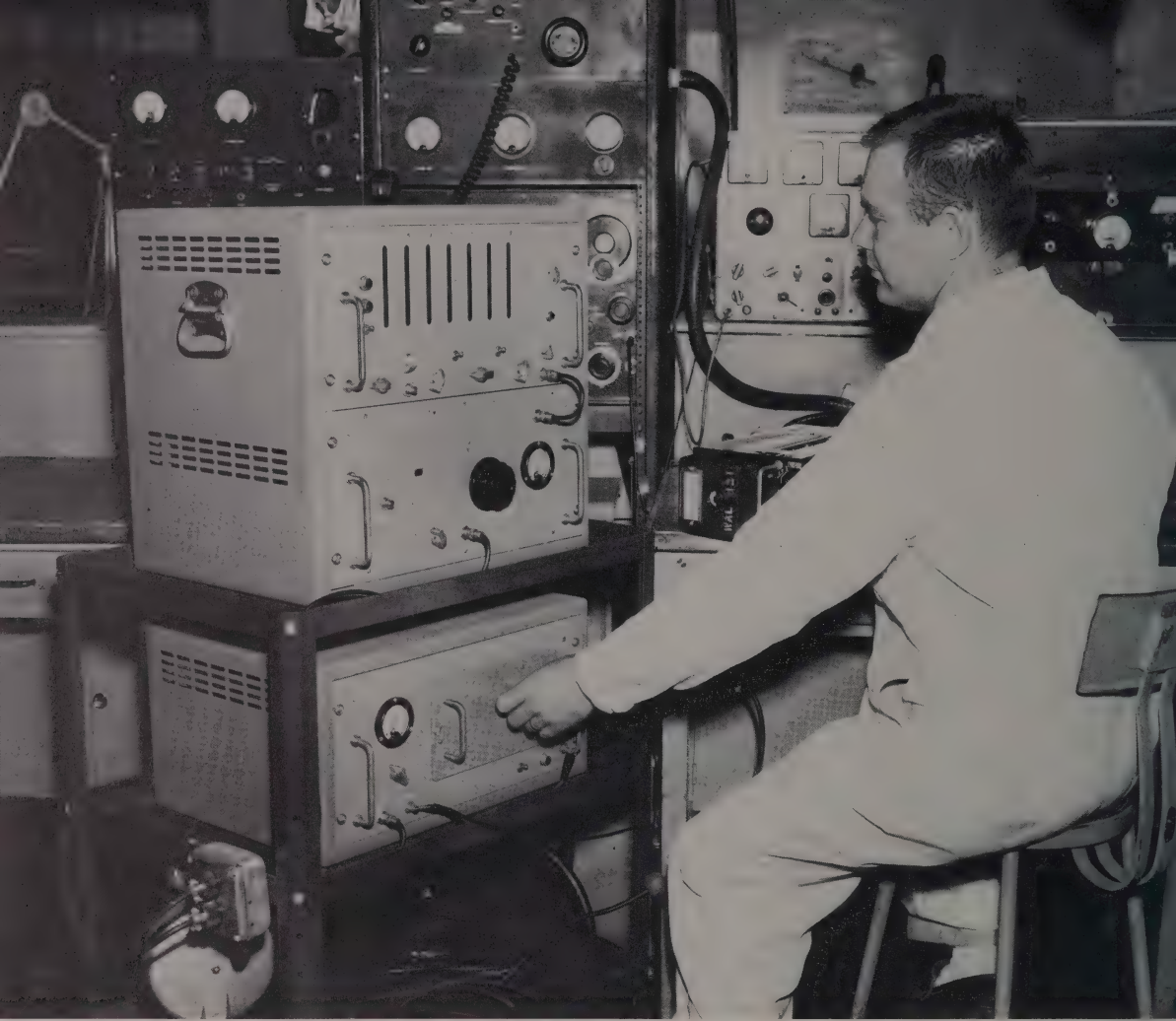
Magnetic DCUs are capable of counting up to 40,000 pulses a second. Units may be cascaded indefinitely to achieve a counter of any capacity. Each DCU counts from 0 to 9 continuously presenting an illuminated reading on the front panel. Reading ease is gained by use of larger panel numbers and lights approximately two and one-half times brighter than comparable vacuum tube type decades.

Elimination of vacuum tubes permits an overall size reduction of up to 32% and a weight reduction of up to 59% over other units. Illustrated magnetic DCUs are plug-in units fitting standard octal sockets. Lower heat

generation resulting from decreased power requirements permits more compact assembly than vacuum tube types.

Magnetic DCUs are true ring-of-ten type counters that use ten ferro-resonant bistable elements so connected that each incoming pulse advances the count one position on the ring. Each of the ten discrete outputs is connected to a neon indicator light. In the Model 736 Dual Preset Magnetic DCU, output pulses are also connected to ten-position selector switches from which two preselectable outputs may be obtained. Accordingly, by cascading Model 736s and adding proper gating circuitry, two independent outputs at any two preselected counts between one and the full capacity of the instrument may be obtained.

In all units output from the number "nine" element is demodulated and brought out to provide a gating voltage for parallel gated counter operation. This output may be differentiated and the leading edge used to drive the next DCU through an intermediate magnetic amplifier.



RECORDERS, READOUTS, EXPLOSION PROOF INDICATORS, and TRANSDUCERS

MODEL 1452 DIGITAL RECORDER

MODEL 5910 INLINE-INPLANE READOUT

MODELS 1941X & 1951X EXPLOSION PROOF INDICATORS

MODEL 454 LIGHT SOURCE

MODELS 453 & 458 PHOTOCELLS

MODELS 441 & 443 REFLECTING TACHOMETERS

MODELS 461, 465, 466 & 467 MAGNETIC TACHOMETER

Two general classes of complementary equipment — readouts and printers greatly extend the usefulness of Beckman/Berkeley counters and timers.

For automatically and permanently recording count information, Model 1452 Digital Recorder works with EPUT® meters, electronic counters, nuclear scalars, time interval meters, and frequency measuring equipment. Both 6 or 8 digit models are available. Code is scanned and printout signals given to a Victor adding machine for making the record.

When remote visual presentation is required, Series 5910 in-line readouts produce large, bright, in-plane numerals for accurate and easy reading even under adverse lighting conditions. This equipment operates from all Beckman/Berkeley counters and timers except Models 5001 and 5010 and magnetic instruments.

Two other inline readout models are enclosed in explosion proof housings. Models 1941X and 1951X are four and five decade readouts for use in locations where explosive vapors are present. When these instruments are used, DCUs are removed from the counter and installed in the remote indicator.

Berkeley's complete line of accessory equipment broadens the application and usefulness of many items of standard equipment.

Transducer equipment consists of both magnetic and photoelectric types. Photoelectric transducers are of two types, reflecting and non-reflecting.

Series 440 photocells are of the reflecting variety, containing both photocell and light source. They may be used where alternate reflecting and non-reflecting surfaces are available, such as a metal disk with black rulings. The 450 Series consists of separate photocell and light source units and is used where a beam of light is to be interrupted.

Series 460 magnetic transducers use a magnetic pickup and a toothed gear. The pickup produces an output signal each time a tooth passes it. These transducers cover a wide speed range and are available with gears of from 30 - 180 teeth.

A new zero speed transducer measures shaft speeds down to zero. This allows measurements to be made through periods of shaft stoppage.

Power supplies for the equipment described above are available if it is not practical to use the instrument accessory socket or for operation with an instrument not having this socket.

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MODEL 1452 DIGITAL RECORDER



SPECIFICATIONS	Model 1452	
Recording and Indicating Capacity	7 digits standard. 8 digits on special order	
Maximum Cycling Rate	1 printout every 0.90 seconds for 6 digits	
Counting Period—Range—Accuracy	Determined by the characteristics of the basic counting instrument	
Visual Display Time	Controlled by counting instrument	
Power Requirements	105-130 volts, 50-60 cycles, approx. 65 w	
Input Requirements	Four-line code from the basic counting unit	
Cable Length	6 feet. Special lengths available	
Dimensions	Approx. 19" wide x 8½" high x 18" deep	
Weight	70 lbs.	
Price: Model 1452	\$950.00	
Modification H	(230/115 v. operation) \$50.00	
Model 506	\$25.00	
folded paper storage box		
Note: To modify older Berkeley instruments for use with the Model 1452, the instrument should be returned to the factory.		
Modification at factory of equipment shipped in last 2 years	4 dcu units	\$205.00
	5 dcu units	\$245.00
	6 dcu units	\$345.00
Modification kit for field modification	4 dcu units	\$170.00
	5 dcu units	\$195.00
	6 dcu units	\$290.00

FEATURES

- Printer and Scanner in Single Compact Unit
- No duplication of Counting Units
- For Bench or Standard Relay-rack Mounting
- Automatically and Permanently Records Information from:
 - Frequency Meters
 - Time Interval Meters
 - EPUT[®] Meters
 - Electronic Counters
 - Scalers

The Berkeley Digital Recorder provides a simple, reliable, yet inexpensive, means of converting electronic count information into printed form. This unit can be coupled directly to a Berkeley electronic counting device and will print sequentially in Arabic numerals on a standard adding machine tape, the total count accumulated by the basic instrument during each of its counting periods. Model 1452 is ideal for long term stability checks, recording of transients or for making permanent printed record in digital control systems. Information that normally would have to be extracted visually and then remembered or written down by the operator is now printed automatically as a matter of permanent record.

The Berkeley Digital Recorder is designed to operate directly from Berkeley Events-Per-Unit-Time Meters, Time Interval Meters, Electronic Counters and Nuclear Scalers which have a 4-line binary code available from each decade. Most new Berkeley instruments have this 4-line code available and provision is made for direct connection to the Model 1452. Most Berkeley counting

equipment now in the field can be adapted for such operation.

Basic Design

Model 1452 consists of a stepping switch, a relay matrix, control and interlock relays, a solenoid operated adding machine and a power supply. The 4-lined coded information is taken directly from each decade in the basic counting unit. This coded output is connected directly to the stepping switch in the Digital Recorder. At the end of the count the basic counter gives a readout command to the Digital Recorder. The stepping switch then scans the information in each Decimal Counting Unit in turn and applies this information through buffers to the relay matrix. The relay matrix is so designed that an actuating voltage will be applied to the same digit of the printer as is shown visually on the Decimal Counting Unit of the basic instrument. When all Decimal Counting Units have been scanned, a print command is given to the adding machine which in turn prints the information shown visually on the electronic counter.

The interlock circuits of the Digital Recorder are so designed that the electronic counter can not automatically clear the visual indication from its own Decimal Counting Units until after the print command has been given. Information will never be cleared from the indicating units before a permanent record is made. Also, the next sample count can be made on the electronic counting device before the printing action is completed. Normal complete printing cycle is 0.85 sec. However, when using the Digital Recorder with an instrument such as the Universal Counter and Timer, it is possible with a time base shorter than one second to obtain printed records at a rate greater than one per second.

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MODELS 5914, 5915 and 5916 IN-LINE INDICATORS



SPECIFICATIONS	Model 5914	Model 5915	Model 5916
Number of digits	4	5	6
Digit size	$\frac{3}{4} \times 1\frac{1}{4}$ inches		
Dimensions (overall)	$5\frac{1}{2}$ " H x $20\frac{3}{4}$ " W x 17" D		
Shipping Weight	34 lbs.	35 lbs.	36 lbs.
Power Requirements	117 Volts AC $\pm 10\%$, 50-60 cps, 125 watts		
Operating Speed	Up to 13 presentations per second		
Input Signals	Binary voltages from counting instruments		
Interconnecting Cable Length	6 ft. standard, 200 ft. maximum		
Price	\$610.00	\$695.00	\$775.00
Modification R (less Cabinet)	$3\frac{1}{2}$ x 19 panel x 17 deep. less \$15.00		
Model 5901	Replacement Digit Module \$110.00		

Modifications Kits for adapting older Berkeley instruments for use with in-line indicators:

P-4 Kit, for Models 5556, 500-B. Use Model 5914 In-line	\$205.00
P-5 Kit, for Models 554, 510, 5500. Use Model 5915 In-line	\$245.00
P-6 Kit, for Models 5558, 5570. Use Model 5916 In-line	\$345.00

FEATURES

- Easy Readability From Any Angle
- Reduces Fatigue
- Greater Accuracy Through Fewer Reading Errors
- Speeds Measurements
- In-line, In-plane Presentation
- High Reliability, Low Maintenance

Reading an electronic counter can often be a difficult job. Scanning up and down the tiny numbers of decimal counting units to determine which ones are lighted and then remembering them in the proper sequence is time-consuming and tiring. Readings from a distance are impossible.

Now Berkeley, the leader in the field of electronic counting instruments, brings you the first practical solution to this problem—a truly in-line, IN-PLANE readout indicator. Large, easy-to-read numbers reduce operator fatigue and provide greater accuracy through fewer readings errors. Easily read from across the room or in a high ambient light level, Berkeley in-line indicators retain their readings while the counter accumulates new data. Then only those digits which differ from the previous reading will change — *automatically!* Making a reading while accumulating data for the next reading allows a sharp reduction in instrument display time, speeds measurements, and makes possible more samples per unit time than ever before without automatic logging equipment. Presentations at rates up to 13 per second can be achieved—higher than the practical limit of visual readability.

One Plane Presentation

Intended primarily as an accessory for counting instruments, each digit of the Series 5910 uses a novel arrangement of seven lighted bars or segments to form any number from zero to nine. Unlike in-line readouts using stacked illuminated lucite plates, each engraved with a single number, or glow tubes having an arrangement of stacked wires which are formed into numbers, the seven segments of the Berkeley indicator present all the num-

bers *in one plane*. There is no masking or cluttering of numbers caused by unused elements “in the way.”

Optional Rack Mounting

Normally supplied in an attractive, lightweight blue wrinkle finish aluminum cabinet, readouts may also be mounted in a standard 19-inch relay rack (3½ inches high). The display units can be placed up to 200 feet from the basic instrument or mounted in explosion-proof housings meeting Class I Group D requirements. A 6-foot cable with connector is supplied for connection to the basic counting instrument.

The Model 5915 5-digit In-line can be used directly with the Berkeley Models 7150, 7250, and 7350.

The Model 5916 6-digit In-line can be used directly with the Berkeley Models 7160, 7260, 7360, 5510 and 5571.

BASIC DESIGN

Each “digit” consists of a plug-in module formed by a printed circuit board, two tubes, four printed circuit relays and a printed circuit display panel. The relays, the finest obtainable using palladium contacts, are guaranteed for fifty million operations. Any relay can be changed without damaging the printed circuit board or the relay coils can be changed without removing the relays. The display panel uses seven miniature “grain of wheat” lamps operating at reduced voltage for long life and mounted in screw-type sockets for ease of replacement.

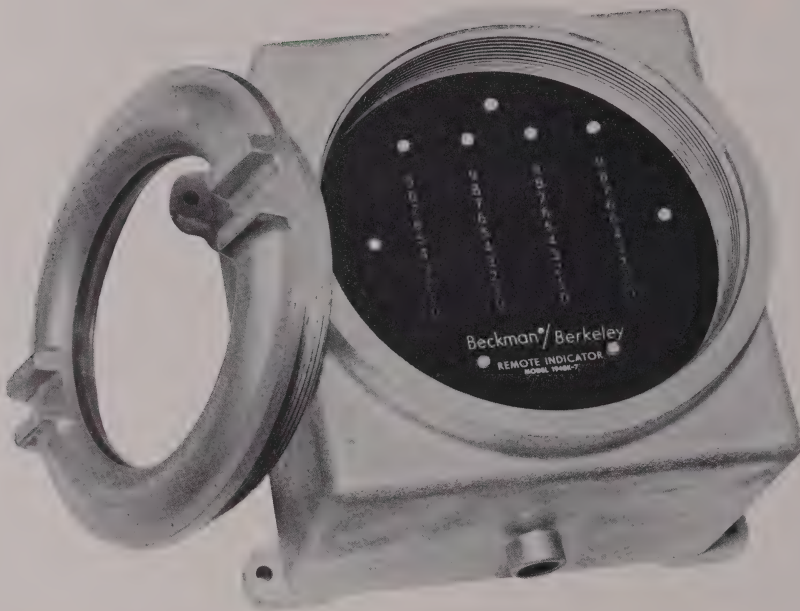
The complete indicator contains from four to six of these modules plus a power supply and latching control circuitry. The front panel carries a power switch, pilot lamp, number display units, an indicator lamp which flashes briefly for each new reading, and a push-button type switch.

Input information to each of the digits is supplied in the form of four binary voltages with values of zero and minus fifteen volts or greater from electronic decimal counting units using 1-2-2-4 weighting. All the newer Berkeley instruments, such as the 7000-series instruments, 5510, 5571, etc., supply these voltages from a connector at the rear.

2

3

MODELS 1941X and 1951X REMOTE INDICATORS



SPECIFICATIONS	Model 1941X	Model 1951X
Readout	4 decades	5 decades
Power Requirements		
AC	117 v 50-60 cps, .5 amp	117 v 50-60 cps, .5 amp
B+	+190 v 70 ma	+190 v 80 ma
B-	-110 v 70 ma	-110 v 80 ma
Housing Specifications	Class I, Group D Class II, Groups EFG Classes III	
Shipping Weight	117 pounds approx.	
Price, f.o.b. Richmond, Calif.	\$245.00	\$345.00
Prices and specifications subject to change without notice.		

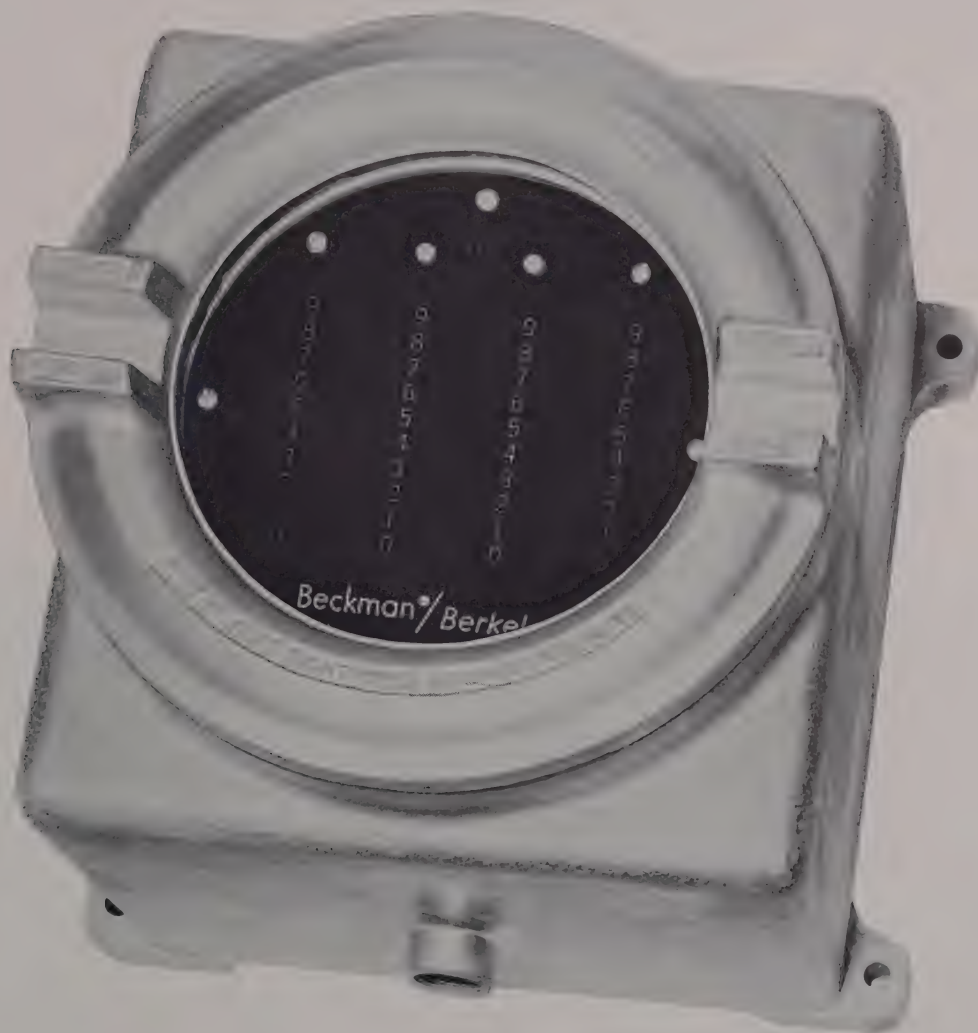
FEATURES

- Four and Five Decade Readout
- Uses Standard DCUs from Berkeley Counters
- Group D Explosion Proofing

Both of these explosion proof indicators permit safe read-out in a dangerous atmosphere. Counters can be located as far as 200 feet from the contaminated area.

Remote indicators consist of a two-tube signal amplifier, sockets for mounting DCUs, and a fan and filament transformer. They are supplied with a 20-foot cable but any length up to 200 feet may be used.

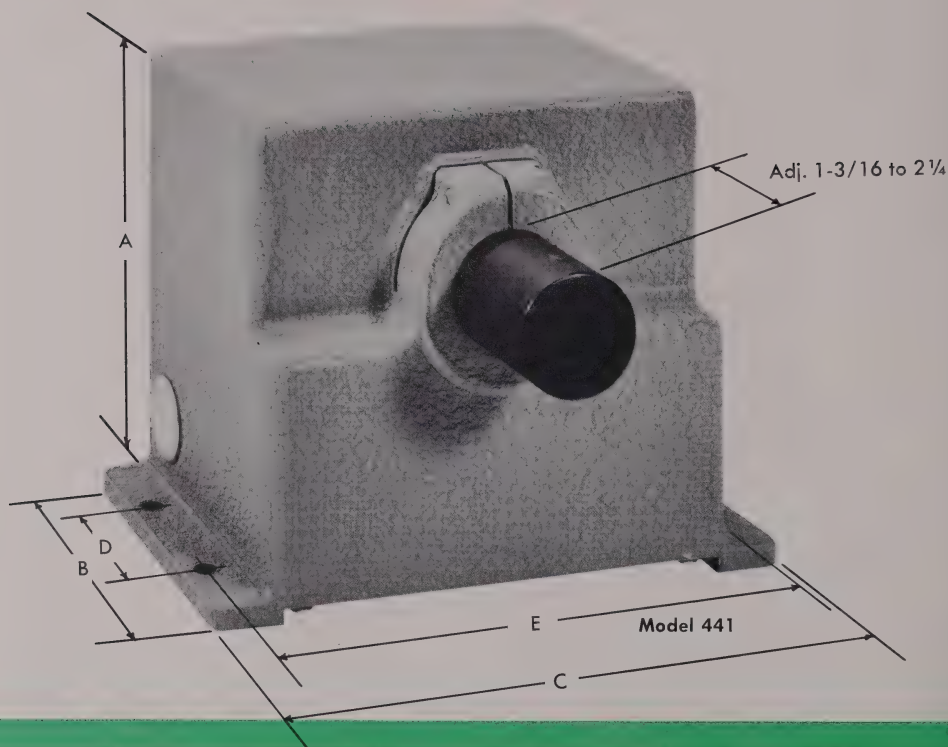
DCU drive signals come from a modified Berkeley counter (Standard Modification V). Models 1941X and 1951X are not supplied with DCUs but use those removed from the counter.



2

4

MODELS 453, 458 PHOTOCELLS — MODEL 454 LIGHT SOURCE



SPECIFICATIONS	Model 453 Photocell	Model 458 Photocell	Model 454 Light Source
Range	0 to 10,000 light pulses per/sec	0 to 100,000 light pulses per/sec	For use with all photocells
Output Signal	1.0V P to P d-c output level adjustable —3 to +3	35V Pulse	
Focusing Range	3 in. to 6 ft. with 454	Same as 453	3 in. to 6 ft. with 453
Image Size	Maximum 1/2"	Same as 453	3/4" x 3/16" at 3" distance
Power Requirements	115V ac	Designed to operate from accessory socket of Berkeley 7000 series instruments or accessory power supply. Requires: +190 v d.c. unregulated; —110 v d.c. unregulated; 6.3 v a.c.	115 V ac
Phototube or Light Source	925	925	#87
Dimensions	A-5 B-3 5/16 C-6 3/8 D-1 3/4 E-5 7/8	Same as 453	Same as 453
Net Weight	4 lbs.	4 lbs.	4 lbs.
Price	\$85.00	\$90.00	\$50.00

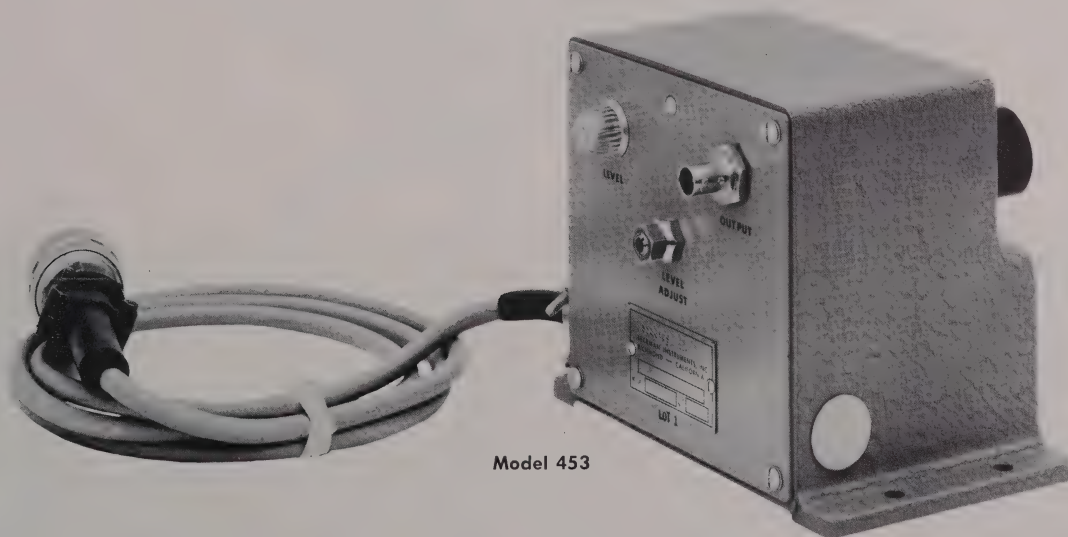
Model 453 Photocell operates directly from 115 volt, 60 cycle a-c line. This unit, used with the Model 454 Light Source, will operate at distances from 3" to 6'. Cathode follower output has been provided with an adjustable d-c output level to permit operation of Model 453 at considerable distances from the counting instrument. Model 453 provides monitoring rates up to 10,000 light pulses per second.

Model 458 photocell will monitor 100,000 light pulses per second. A built-in shock mounted amplifier offers extremely stable vibration free operation. The Schmitt

trigger output circuit yields a fast rising 35 volt pulse. A built-in neon indicator facilitates adjustment of the trigger level. Where minute increments of time are under measure, this unit is highly useful.

Light Sources

Model 454 Light Source operates with Models 453, 458, and other Berkeley photocells. It may be plugged directly into a 115 volt a-c source. A new lens system permits operation at separations of 3" to 6'. For special applications Model 430A or 430B lens adapters offer operating distances of $\frac{1}{2}$ " or $\frac{3}{8}$ ", respectively.

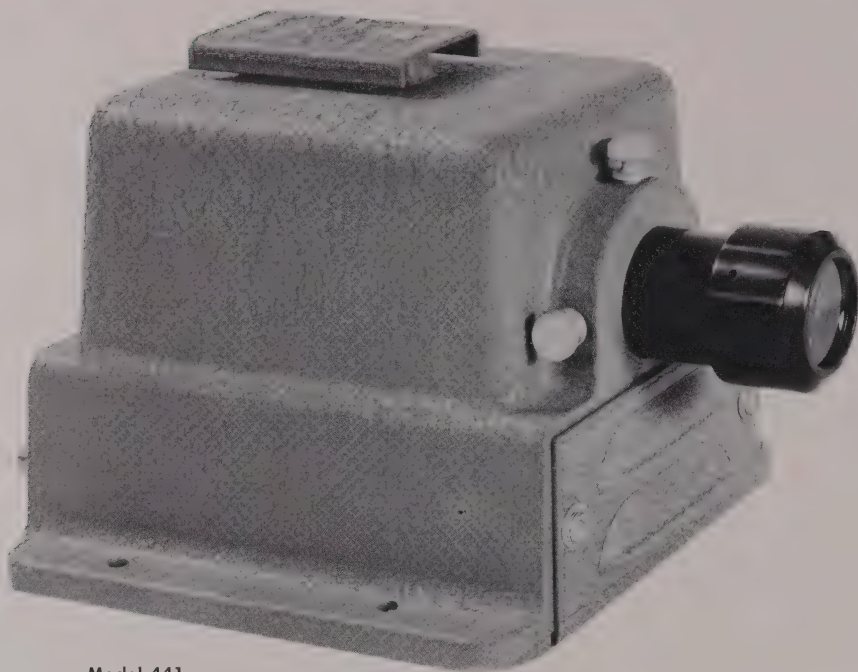


Model 453

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5

MODELS 441, 443 REFLECTING PHOTOELECTRIC TRANSDUCERS



Model 441

SPECIFICATIONS	Model 441	Model 443
Range	100 to 20,000 light impulses per second	0 to 10,000 light impulses per second
Power Requirements	Designed to operate from accessory socket of Berkeley 7000 Series Instruments or accessory power supply	
Requires	+120 v d.c. regulated, 10 ma 6.3 v a.c., 2 amps	+120 v d.c. regulated, 2 ma —110 v d.c. unregulated, 3 ma 6.3 v a.c., 3 amps
Output Signal	1.5 volts p to p ac coupled	4.0 volts p to p d.c. coupled; level adj —3 to +2 v
Working Distance	2"	1½"
Focusing Range	¼"	½"
Image Size	1/32" x 1/8" std. lens	0.19 x 0.05 inches
Dimensions	6" x 5¼" x 5"	4" x 2¼" x 4"
Price	\$135.00	\$195.00
Net Weight	4 lbs.	3 lbs.

Berkeley reflecting photoelectric transducers are ideally suited for applications where it is impractical to load the rotating member or where partial revolutions are encountered. When discs containing a small number of segments are used, very high rotational speeds may be measured.

Model 441

Berkeley Model 441 Reflecting Photocell Pickup is a combination photocell and light source capable of operating from 100 to 20,000 light impulses per second. The unit is contained in a single housing with one lens system to facilitate ease of focusing.

When used as an electronic tachometer, the light from the Model 441 passes through a semi-transparent mirror and is focused on a shaft or disk by a lens system. The shaft or disk of the prime mover can have any number of alternate reflecting and non-reflecting segments depending on the application. Light is reflected from a reflecting segment back through the lens system and the mirror deflects the incoming light through an aperture to the phototube. The Reflecting Photocell need only be placed a fixed distance from the shaft or disk to obtain

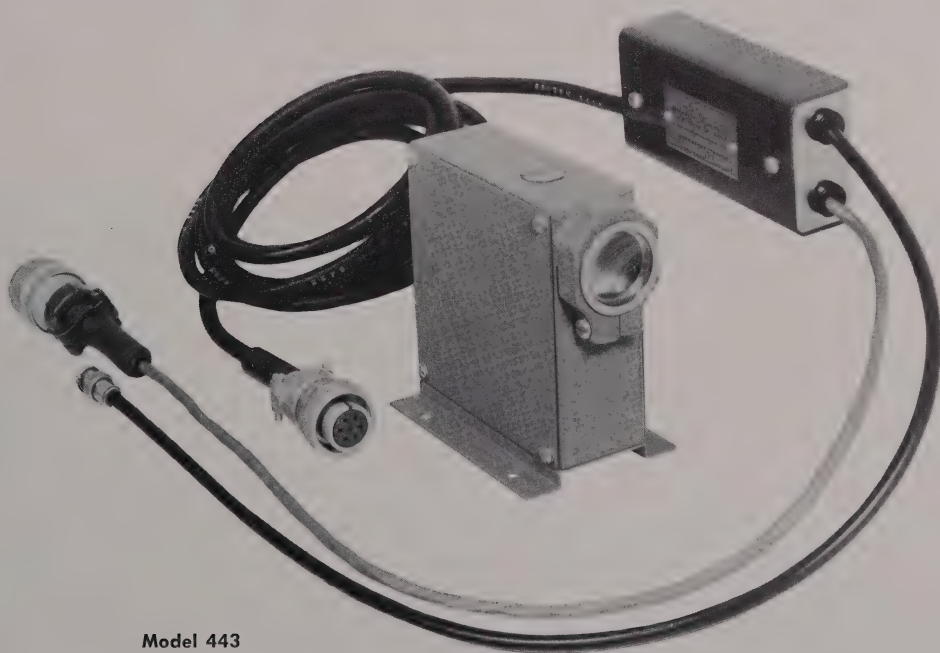
proper operation. It is not necessary to focus two lens systems.

The unit consists of light source and lens system, a semi-transparent mirror, a phototube, and a high gain amplifier and cathode follower. The lens system has a focal distance of 2 inches and is mounted in a 1 1/4" diameter lens holder tube.

The mirror is made of special coated glass that reflects 40% and transmits 60% of the light with a loss of 1%. The phototube is a type 929, A.C. coupled to the high gain amplifier which is followed by the cathode follower stage. Since this unit is A.C. coupled, no adjustment is needed for proper signal output. Operating power is obtained from the accessory socket of the 7000 series instrument used with the Model 441.

Model 443

This model is basically similar to the Model 441 except that it is housed in two separate units. Adjustment of the DC level can be made at the unit located near the counter. Only focusing operations need be made at the pickup unit.

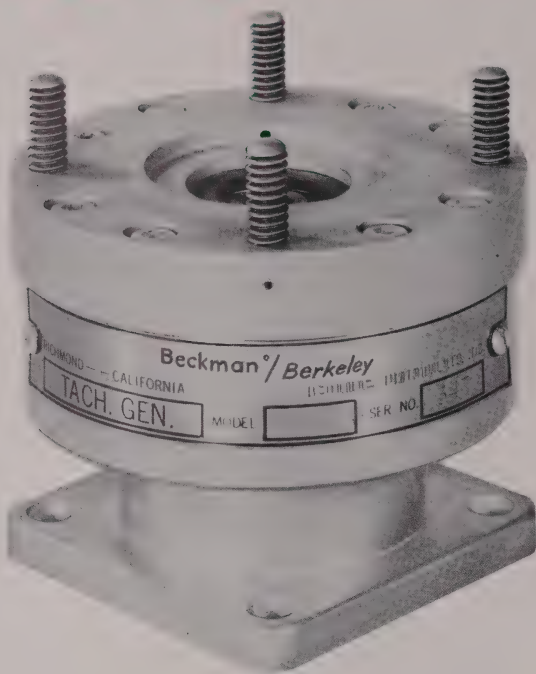


Model 443

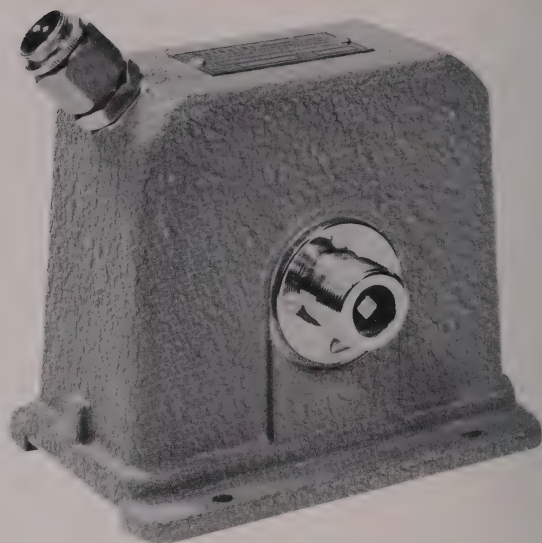
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6

MODELS 461, 465, 466 and 467 TACHOMETER TRANSDUCERS



Model 466



Model 461

SPECIFICATIONS	Model 461	Model 465	Model 466	Model 467
Speed Range	200-7500 rpm	25-7500 rpm	25-10,000 rpm	0-3,000 rpm
No. of Teeth	1 to 180	30 to 180	30 to 180	1 to 100 lines
Standard Housing	4 3/4" x 4" x 4 3/16"	2 7/8" dia. x 2 19/32"	3 1/8" dia. x 2 11/32"	
Explosion Proof Housing (Mod X)	7" x 8 1/2" x 5 1/2"			
Weight (Mod X)	5 lbs.	1 1/2 lbs.	2 1/2 lbs.	
Price f.o.b. Richmond, California	461: \$150. 461X: \$235.	\$290.	\$290.	\$150.

Berkeley tachometer transducers find application in numerous locations where it is desired to monitor rotational speed. Magnetic transducers consist of a steel gear and a magnetic pickup. When a tooth passes the pickup an output pulse is produced. These pulses may be counted with a wide variety of Berkeley electronic counters.

Model 461

Model 461 Tachometer Pickup is an accessory unit for measurement of r.p.m. for use with the Berkeley Events-Per-Unit-Time Meters, the Universal Counter and Timer, and the Industrial Tachometer Series 5600. Rotational speeds from 200 to 7,500 r.p.m. with short term excursions to 10,000 r.p.m. can be translated into pulses giving an accuracy of ± 1 r.p.m. or greater. By selection of the proper number of teeth on the Model 461 and the counting interval of the scaling unit it is possible to obtain direct reading in r.p.m. even though the prime rotating shaft is geared down to the tachometer take off point in an odd ratio.

Modification X permits use of this unit in Class 1, Group D explosion proof areas.

The unit consists of a magnetic pickup and a tachometer gear which is mounted on a .250 inch shaft running on sealed ball bearings. The gear may have 1 to 130 teeth according to the requirements of a particular installation. Standard have 60, 100, 119, 120, and 143 teeth. The unit functions on the principle of voltage induced by varying the reluctance of the magnetic circuit. As a gear tooth moves past the metallic point of the pickup, the reluctance of the circuit varies, inducing a voltage change in the pickup coil. The number of voltage pulses per revolution corresponds to the number of gear teeth.

The unit is placed in operation by simply coupling the shaft of the tachometer pickup to the desired rotating shaft. Since the tachometer has a low output impedance, the signal can be carried by a cable for comparatively large distances without serious deterioration of the pulse amplitude.

Model 465

This unit consists of stator formed by a divided housing, a rotor, and a coil. Each of the two housing halves is fabricated to contain the rotor, and each has an internal ring of gear teeth. The coil fits into the upper housing. The rotor shaft is composed of a gear, an Alnico magnet, and a spacer press-fitted on the center portion of the shaft. As the rotor turns, a change in reluctance occurs between the shaft gear and the housing gears. This change induces a voltage in the coil. The reluctance change occurs every time the opposing gear teeth change from tooth-opposite-tooth, to tooth-opposite-slot. The voltage output is dependent on the reluctance change in a number of magnetic paths simultaneously, giving an output greater than that obtained from the Model 461. The output frequency in cycles per revolution is equal to the number of gear teeth. The mounting end of the pickup is constructed for mounting on tachometer pads conforming to Air Force, Navy Aeronautical standard drawings AND 20005.

Model 466

Model 466 is similar to Model 465 but was designed

with emphasis on compactness and the ability to withstand severe vibrations. This unit was designed primarily for aircraft engine testing but can be used in many industrial installations. It mounts on tachometer pads conforming to Air Force, Navy Aeronautical standard drawings AND 20005.

Model 466 is provided with a "thru" shaft and has a mounting pad at each end of the shaft. This unit can then be coupled directly to the rotating element and also provide a mounting for a standard tachometer if desired. This model is ideal for engine testing where it is necessary to indicate accurately the steady state RPM and still achieve an indication of any transient changes. The distance between mounting pads of the Model 466 is $2\frac{1}{4}$ ".

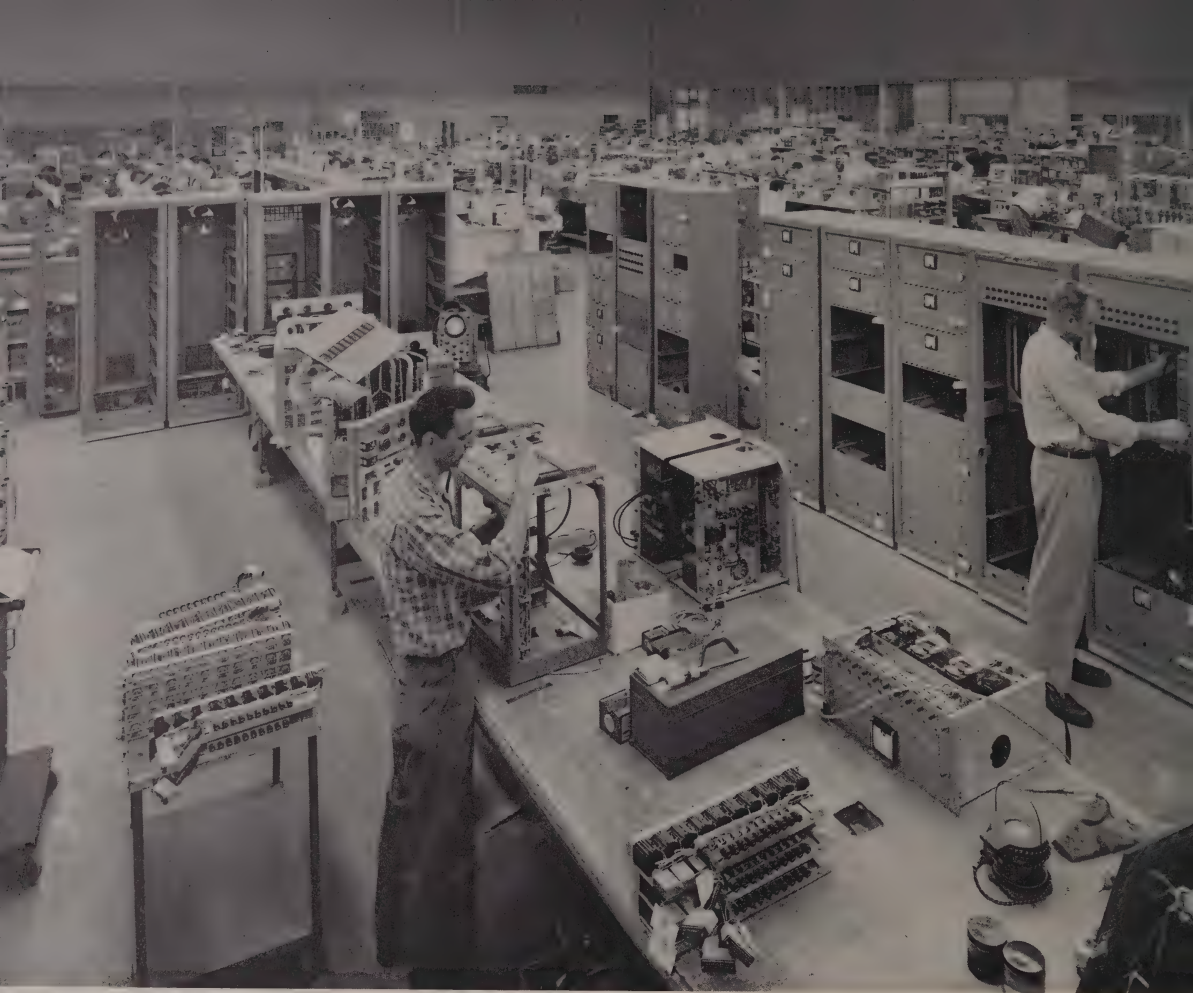
Model 467

Model 467 zero speed Capacitance Tachometer Generator is an accessory unit for obtaining digital control and digital indication of shaft positions and shaft rpm. This unit has been designed for use with the Berkeley Events-Per-Unit-Time Meters, the Universal Counters and Timers, and the Industrial Tachometer series. Rotational speeds from 0 to 3,000 rpm can be translated into pulses giving an accuracy of ± 1 rpm or greater.

The unit consists of two discs, one of which is held stationary. The capacity between the two discs varies according to the relative position of the two discs and will be highest when the conducting elements of the discs are opposing each other and lowest when they are between. An oscillator and a detector are used to turn this variation in capacitance into electrical signals that will operate electronic counters. The oscillator frequency used is 1 megacycle and the tuned circuit consists of a center tap secondary of a transformer, two fixed and one variable capacitor, and the capacitor formed by the two discs of the rotating system. The tuned circuit is arranged as a bridge balancing capacitance of the rotating system against a variable capacitance. Unbalance in the bridge results in an RF voltage occurring at the center tap of the coil.

The RF voltage is rectified in the detector and comes out as a negative signal that is added to a positive bias voltage applied to the cathode of the detector. The output voltage will vary as a sine function when the disc is rotated and there will be as many cycles per revolution as there are lines on the disc. The rotating system with the two discs is made as a separate assembly that is put together and adjusted before mounting the housing. A separate set of pre-loaded bearings is used between the rotor and the stator which makes it possible to maintain a close and accurate spacing between the discs unaffected by any load put on the end of the driving shaft.

Since the tachometer has a low output impedance, the signal can be carried by a cable for comparatively large distances without serious deterioration of the pulse amplitude. The discs may have from 1 to 100 lines according to the requirements of a particular installation. By selecting the proper number of lines on the Model 467, and the counting interval of the scaling unit, it is possible to obtain direct reading in rpm even though the prime rotating shaft is geared down to the tachometer takeoff point in an odd ratio.



SPECIAL and GENERAL PURPOSE INSTRUMENTATION

MODELS 101 & 101R EXPANDED SCALE VOLTMETERS

MODELS 101-50 & 101-50R EXPANDED SCALE VOLTMETERS

MODEL 115 EXPANDED SCALE VOLTMETER

MODEL 404 & 404R EXPANDED SCALE FREQUENCY METERS

MODEL 100 TRANSFORMATION RATIO METER

MODEL 605 WIDE RANGE RESISTANCE BRIDGE

MODELS 903 & 4904 DOUBLE PULSE GENERATORS

Beckman/Berkeley has added a line of special and general purpose equipment to supplement its digital instruments.

Each of these instruments is designed to perform a specific type of measurement. This group contains instruments for frequency, voltage, and resistive measurements. For the most part, these instruments are analog in nature, although two double pulse generators are included.

These instruments are designed and built to Berkeley's high quality standards and are intended for both laboratory and industrial applications.

3 - 1

MODELS 101 & 101-50 EXPANDED SCALE VOLTMETERS



SPECIFICATIONS	Model 101	Model 101-50
Range	100 v to 500v	50 v to 250 v
Scale Range	12 v	6 v
Smallest Scale Division	0.2 v	0.1 v
Waveform Error	Less than +1.5% or -5.5% for all waves having crest factors of 2 or less	
Frequency Response	50 to 2000 cps	
Accuracy	± 0.25 or Input Voltage for Sine Waves	
Source Loading	Approximately 2 watts	
Meter Damping	0.8 of Critical Damping	
Time Response	0.5 seconds	
Recorder Connections	0-1 ma dc recorder	
Power Requirements	115 v ac, 50-2000 cps, 25 watts	
Dimensions (Portable)	8" W x 9 $\frac{3}{4}$ " H x 9" D (14 lbs. net)	
Dimensions (Rack)	19" W x 5 $\frac{1}{4}$ " H x 9" D (15 lbs. net)	
Price (Portable)	\$360.00 f.o.b. factory	
Price (Rack)	\$400.00 f.o.b. factory	

FEATURES

- Accuracy: $\pm 0.25\%$
- Portable or Rack Mounted
- Drives 0-1 ma Recorder

Expanded Scale Voltmeters are invaluable for all types of testing and development work where high accuracy is a requisite: production quality control of components and circuits, developing new circuits, servicing electronic instruments and systems, and measuring voltages in a-c power systems. Voltage variations can be recorded for permanent records, or for regulation investigations. Expanded Scale Voltmeters are accurate and rugged... designed for hard use on plant production lines, and for measurements of line voltage variations in the field. They are ideal for use where vibration might damage more delicate meter movements. The accuracy is constant and dependable. These general purpose Expanded Scale Voltmeters fill a long-standing need. They enable high voltages to be read accurately to $\pm 0.25\%$ of input voltage. Optimum meter damping reduces reading time and facilitates measurement of voltage variations.

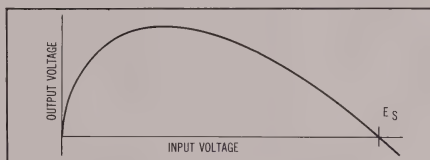
Two models are presently available: the 101 which reads from 100 to 500 volts in 10-volt steps and the 101-50 which reads from 50 to 250 volts in 5-volt steps. The 101R and the 101-R-50 are rack-mounting versions of these two instruments.

Operation consists of turning the two voltage-range switches until the meter reads on-scale. Input voltage is obtained by adding the voltages indicated on the two panel switches to the voltage registered on the scale. A 0-1 milliamperere recorder may be attached directly to the Expanded Scale Voltmeter. If a 2% accuracy recorder is used, the accuracy of the recorded measurement will be $\pm 0.25\%$ of the input voltage. Recorder full scale is always 12 volts. (6 volts for the Model 101-50).

A limiting circuit protects the meter movement from over- or under-voltage damage. Operating power may be obtained from the source to be measured if desired. Frequency of usable power is 50 to 2000 cps.

Circuitry

A thermal bridge is used as the voltage standard in both models of the expanded-scale voltmeters. By exploiting the nonlinear properties of a hot wire, a highly stable voltage standard has been developed. This element is used in a bridge circuit with wirewound resistors to give a system whose output is shown below.



Characteristic of hot-wire thermal bridge used as voltage standard.

The output voltage goes through a null at an input of E_s . For small deviations from E_s , the output voltage is proportional to $E_{in} - E_s$. Since the bridge unbalance is produced by heating of the wire, the indication is rms and independent of frequency.

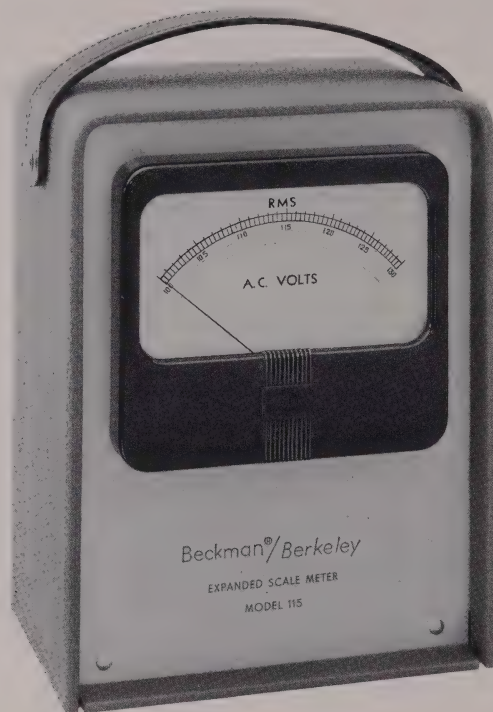
The temperature coefficient of the bridge is very small because of the high operating temperature of the wire in the nonlinear element; a change in ambient contributes only a small percentage to the wire's temperature rise. The high operating temperature of the nonlinear element also produces rapid response to voltage changes.

The output voltage of the thermal bridge is amplified and measured by the panel meter. A phase-sensitive circuit is used so that the meter will read upscale only when the unbalance is on the high side of the balance point.



3 - 2

MODEL 115 EXPANDED SCALE VOLTMETER



SPECIFICATIONS	Model 115
Voltage range	100-130 v
Accuracy	± 0.7 volts
Frequency range	50-2000 cps
Temperature range	0-40° C.
Input power required	0.5 watts max.
Dimensions	6" W x 8" H x 4" D
Net Weight	2½ lbs.
Price (f.o.b. Richmond, California)	\$105.00

FEATURES

- Accuracy: ± 0.7 volts obtained from unique scale expansion, not from delicate meter movement
- Overvoltage protection: Up To Twice Maximum Scale Voltage
- Passive Circuit Gives Scale Expansion
- Ruggedness Minimizes Maintenance
- Convenient — Easy to Read
- Errors From Parallax Reduced — Mirrored Scale Added For Convenience
- Portable, Lightweight and Compact

The Model 115 is an expanded scale voltmeter designed to measure a-c voltages of 100-130 volts with an accuracy of ± 0.7 volts. Compact, portable and rugged, it is ideal for the measurement of line voltages in remote locations where accuracies approaching laboratory standards are desired. Observations of line fluctuations and transients are simplified because of the unique scale expansion. The method of accomplishing this scale expansion is described below.

It should be noted that Model 115 is a precision instrument, not a mechanically-suppressed-zero type of meter movement. Using no terminals or probes, the operator simply plugs the line cord plug into a 100-130 V a-c line receptacle and reads the line voltage on the large expanded scale. For a moment after power applied the meter pointer will deflect beyond the left-hand end of the scale. As the thermal bridge comes up to temperature, the pointer returns on scale. This takes about 1 second.

Circuitry

The 115 circuit consists of a step down transformer, a thermal bridge, a phase sensitive demodulator and a 0-1 MA meter.

The output of the thermal bridge is shown in figure 1.

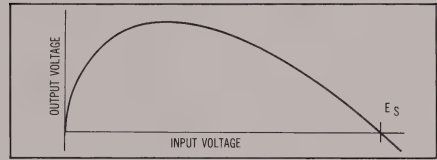


Figure 1. Characteristic of hot-wire thermal bridge used as voltage standard.

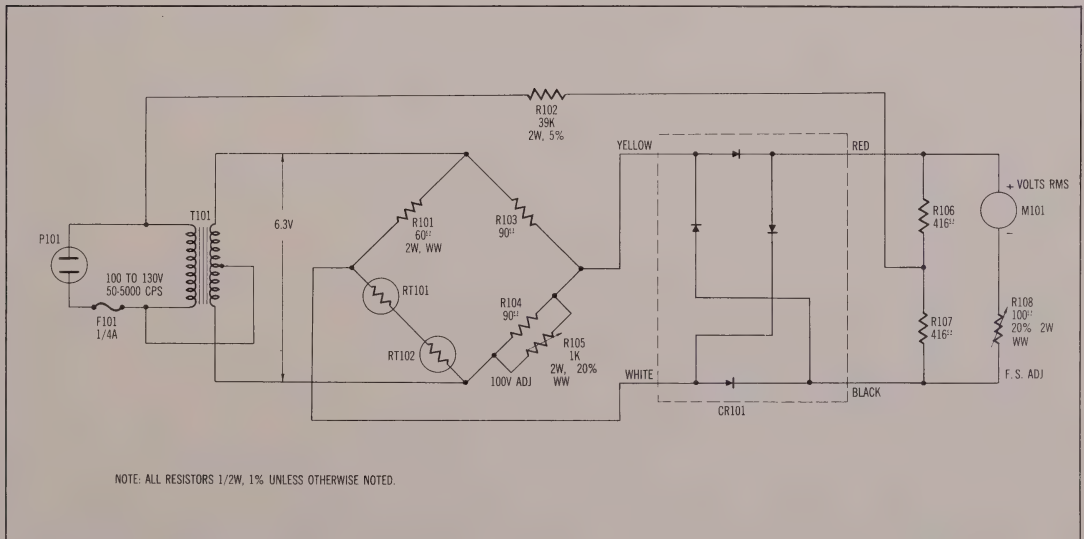
The output voltage goes through a null and a 180° phase inversion at an output voltage E_s . For small deviations from E_s the output voltage is proportional to $(E_m - E_s)$. The output of the thermal bridge is fed to a phase sensitive detector. The detector develops a d-c voltage proportional to the magnitude of the thermal bridge output. The sign of this d-c voltage reverses as it passes through zero. This reversal, as the bridge temperature rises, accounts for the initial deflection of the meter to the left when the instrument is first connected.

Adjustments

The chassis may be exposed by removing the two screws holding the leather handle and lifting cabinet upwards.

Two adjustments are provided. A ¼ % or better voltage standard is required for adjustment.

Apply 100V to the power cord and adjust R105 (100V ADJ) for a correct reading. Increase input voltage to 130V and adjust R108 (F.S. ADJ) for a 130-volt reading.





SPECIFICATIONS	Model 404
Range	375 cps to 425 cps
Accuracy	± 0.5 cps. Error due to harmonics less than 0.5 cps for 5% harmonic content. Error due to voltage change less than 0.25 cps from 100 to 130 volts.
Input Requirements	105 to 125 volts, $1\frac{1}{2}$ watts
Recorder Terminals	Current -0.5 to 0 to $+0.5$ ma. Recorder resistance should be $1400\Omega \pm 20\%$. Internal damping resistance $30,000\Omega \pm 50\%$.
Power Requirements	100 to 130 volts, 50 to 2000 cps, 25 watts
Outside Dimensions (Portable)	8" W x 10" H x 9" D (12 lbs. net)
Price (Portable)	\$330.00 f.o.b. Richmond, California
Outside Dimensions (Rack)	19" W x $5\frac{1}{4}$ " H x 9" D (14 lbs. net)
Price (Rack)	\$380.00 f.o.b. Richmond, California

FEATURES

- Accuracy: ± 0.5 CPS.
- Will Drive 0-1 MA Recorder
- Does Not Require Reference Frequency
- Available in Either Portable or Rack Mounting

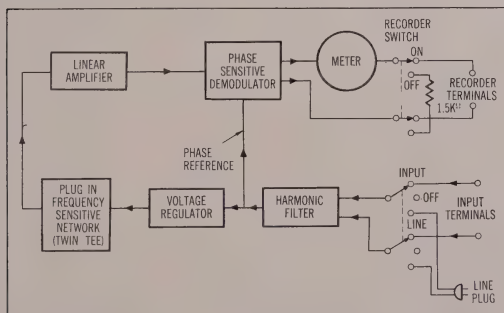
The Expanded Scale Frequency Meter is designed for fast accurate monitoring of frequencies near 400 cps. It was originally intended for use in making production inspection measurements of the frequency regulation of motor and engine driven generating units, but has found many other applications where a record of frequency is desired.

This instrument will measure the frequency of the line supplying its power or the frequency of an external signal introduced at a separate input connector. Frequency is indicated on a front panel meter which covers the range from 375 to 425 cps. With this large scale expansion, reading errors due to parallax are insignificant. In addition, a range light is provided on the front panel which lights when the measured frequency is within approximately ± 50 cycles of the center frequency.

A 0 to 1 milliampere recorder may be attached directly to the instrument. This instrument has been designed to present critical damping resistance to the Esterline-Angus recorder but other recorders may be used. A current-limiting device is included to protect both the recording meter and the panel meter.

Circuitry

The block diagram below shows the main functional components of the frequency meter. The signal of the frequency to be measured is first passed through a harmonic filter and a voltage regulating circuit to obtain a pure



sinusoidal signal of constant amplitude. This signal is fed to a phase shifting network and then to the twin-tee network.

The twin-tee network senses both the magnitude and the direction of frequency deviation from the center frequency. Its output voltage is proportional to the difference between the input frequency and the center frequency. At 400 cps the output is zero; as the frequency deviates below or above 400 cps, the output voltage rises linearly. The phase of the twin-tee output depends upon whether the input frequency is above or below 400 cps. The output when above 400 cps is 180° out of phase with the output when below 400 cps.

The linear amplifier is a combination voltage and power amplifier which contains enough negative feedback to preserve the linear relationship of frequency deviation to voltage created by the twin-tee. Phase shift occurring in both the twin-tee and the linear amplifier causes the output of the amplifier to be in phase with a reference signal when the frequency is above center, but 180° out of phase with the phase reference when the frequency is below center.

The phase-sensitive demodulator puts out a d-c current whose amplitude is proportional to the a-c voltage from the amplifier. Direction of this current is determined by the phase difference between the amplifier output and the phase reference signal. When the amplifier output is zero (that is, when the input frequency is at 400 cps) no current flows in the meter and the pointer rests at the center position. When the amplifier output is above zero and 180° out of phase with the reference signal, (that is, when the input frequency is below 400 cps) the meter is deflected to the left. When the amplifier output is above zero and in phase with the reference signal (that is, when the input frequency is above 400 cps) current flows through the meter in the opposite direction.

The slight non-linearity of output vs input voltage of the phase shifting amplifier is compensated for in the meter circuit by a calibrating resistor shunted with a diode. When the frequency is below 400 cps, the meter current flows through the resistor. When the frequency is above 400 cps the meter current reverses and the calibrating resistor is practically shorted by the diode. Therefore, the instrument is essentially linear from 375 cps to 425 cps. Maximum possible error is constant throughout the entire range.

3

-

4

MODEL 100 TRANSFORMATION RATIO METER



SPECIFICATIONS	Model 100
Accuracy	$\pm 0.2\%$
Scale Range	$\pm 3\%$ zero center
Smallest Division	0.1%
Waveform Error, Max.	0.2% for 5% Harmonic
Input Voltages	57.3, 78.0, 90.0, 105.0, 115.0
Frequency Response	50 to 1000 cps
Input Impedance	10,000 Ω /Volt Nominal
Overvoltage Protection	150V may be applied continuously
Power Requirements	105-125V; 50 to 1000 cps; 25 watts
Dimensions	8" W x 9 $\frac{3}{4}$ " H x 9" D (12 lbs. net)
Finish	Beige Panel; Green Wrinkle Cabinet
Price	\$400.00 f.o.b. Richmond, California

FEATURES

- Simple to Operate
- Expanded Scale
- Direct Reading in Percent of Deviation
- Tests Synchro Transmitters and Receivers
Differential Transmitters and Receivers
Control Transformers
According to Mil-S-12472 Paragraph 4.7
- High Impedance: 10,000 ohms/volt
- Portable—Light Weight

Model 100 Transformation Ratio Meter is an RMS reading expanded scale voltmeter designed to compare the primary and secondary voltages of synchros faster and easier than by conventional methods. The method of operation is ideally suited for production testing as well as for inspection of synchros and control transformers.

The design may be modified for other primary and secondary voltages between 35 and 300 volts.

Circuitry

Model 100 circuitry consists of a precision voltage divider, input switching, and a high expanded scale volt-

meter. The expanded scale voltmeter is calibrated to read full scale with a $\pm 3.0\%$ change of voltage from the nominal voltage. A zero adjustment knob permits zeroing the instrument when the test supply voltage is within $\pm 3\%$ of the nominal value. The nominal voltages are 57.3, 78.0, 90.0, 105.0, or 115.0 volts. Two rotary switches select the voltage divider taps for the primary and secondary inputs, respectively. The PRISEC selector switch connects the proper input to the meter.

The expanded scale voltmeter contains a high stability amplifier. Negative feedback makes the performance independent of tubes and components to an extent necessary for the high accuracy of this instrument. The output of the amplifier operates a bridge containing a voltage sensing thermal element. This element is operated at a high temperature so that its resistance is independent of ambient temperature. At a particular voltage, the resistance of the thermal element is balanced by a fixed resistor and no output is obtained. For small deviations from this voltage, the output of this non-linear bridge is proportional to the voltage difference.

The output of the amplifier supplies a neon lamp to indicate an overload on the instrument.

3 - 5

MODEL 605 WIDE RANGE RESISTANCE BRIDGE



SPECIFICATIONS	Model 605
Resistance Ranges	0 to 100 Ω , 1K Ω , 10K Ω , 100K Ω , 1M Ω , 10M Ω , 100M Ω
Accuracy	$\pm$ (.15% of resistance measured $\pm$.05% Full Scale)
Drift	Negligible after 30 minute warm-up
Tube Complement	1-0B2, 1-5963
Batteries	1-45 Volt, 2-7½ Volt
Power Requirements	105-130V, 50-60 cps, 15 watts
Case Dimensions	9¾" H x 8" W x 9" D
Weight	8 lbs.
Price	\$170.00 f.o.b. Richmond, California

FEATURES

- 100 ohm to 100 megohm ranges
- Push Button Operation
- High Accuracy
- Simple to Operate
- Guard Terminal Provided
- Constant Sensitivity on All Ranges

Model 605 provides a means for rapidly and easily checking resistances to a high degree of accuracy. Seven ranges for full scale resistance values are selectable by front panel push button switches. In operation, the unknown resistance is connected to the appropriate terminals, the range switch set, a key depressed and the Helipot® precision potentiometer turned to obtain a null indication on the large 4" zero center galvanometer. The value of the unknown is then read directly from the potentiometer dial setting and multiplied by the appropriate factor of ten.

By using a multi-turn Helipot® precision potentiometer, this bridge is capable of maintaining a high resolution throughout the entire range. This potentiometer also provides a direct reading linear scale not usually found on instruments of this type.

The guard terminal enables the operator to measure high resistances by bypassing the shunting leakage resistance. It may be used with leakage paths of 50 megohms or more.

Circuitry

The circuit of this instrument consists of a DC bridge, of which the Helipot® potentiometer and the unknown constitute two arms. The bridge is energized by a battery in order to have a ripple-free, stable DC source. Since negligible current is drawn, the life of the battery is practically equivalent to the shelf life.

The push button range switch selects one of six precision resistors for one of the bridge arms, the correct battery, and a 10:1 or 1:1 ratio arm. Because of the high accuracy of all resistance in the circuit, the resistance of the Helipot® at balance when properly calibrated is proportional to the unknown resistance which is read directly from the dial.

Bridge unbalance voltage is fed to a vacuum tube circuit to provide isolation and high sensitivity. The microammeter, connected between the plates of two halves of a Type 5963 vacuum tube, indicates the presence of any potential on the grid of the section connected to the bridge output.

3 - 6

MODELS 903 and 4904 DOUBLE PULSE GENERATORS



SPECIFICATIONS	Model 903	Model 4904
Pulse Width	0.15 to 1.8 μ sec.	0.3 to 10 μ sec.
Maximum Pulse Amplitude	200 volts negative, 50 volts positive across 1000 ohm load. 10 volts negative and 2.5 volts positive across a 50 ohm load	160 volts negative and 75 volts positive across a 1000 ohm load. 5 volts negative and 2 volts positive across a 50 ohm load
Rise Time	0.035 μ sec.	0.08 μ sec.
Decay Time	0.15 μ sec.	0.26 μ sec.
Pulse Polarity	positive or negative	positive or negative
Pulse Spacing	0 to 10 μ sec. Single control	0 to 100 μ sec. Coarse and fine adjustments
Internal Drive	1 to 1000 cs.	1 to 10,000 cps.
External Drive	1 to 1000 cps by negative 100 volt pulse with 0.5 μ sec. rise time and 2 μ sec. duration	1 to 10,000 cps by sine wave 3 volts rms, or positive pulse 7.5 volts and 1 μ sec. duration
Oscilloscope Sync.	30 volt positive pulse 1 μ sec. before first pulse	30 volt negative pulse 5 μ sec. before first pulse
Power Requirements	117 volts $\pm$ 10% 50-60 cps. 90 watts	117 volts $\pm$ 10% 50-60 cps. 275 watts
Shipping Weight	41 lbs.	75 lbs.
Cabinet Dimensions	14 $\frac{1}{4}$ " x 9 $\frac{3}{4}$ " x 10 $\frac{3}{4}$ "	20 $\frac{3}{4}$ " x 10 $\frac{1}{2}$ " x 15"
Panel Size	8" x 13"	19" x 8 $\frac{3}{4}$ " Standard rack mounting
Price	\$495.00	\$645.00

Berkeley Double Pulse Generators are general purpose laboratory instruments that provide a source of "clean" paired or single pulses. Pulse width, pulse amplitude, pulse to pulse spacing, pulse polarity and repetition rate may be independently adjusted. The resulting variety of pulse shapes available make the double pulse generators extremely useful in electronic test and development work.

These instruments consist of two basic pulse forming circuits which are triggered at a variable repetition rate by either an internal or an external frequency source or by a manually operated switch. A time delay circuit provides the variable separation between the first and second output pulses. Output of each pulse forming circuit is obtained from a power amplifier which gives large output pulses with small base line variations.

Outputs may be mixed internally in a non-interacting circuit to give two pulses which are identical in amplitude and polarity but independently variable in width and spacing. In addition, separate connectors provide for external mixing of the pulses so that independent variation of all parameters can be obtained.

Two output terminals are provided for each pulse output. The high level output has an internal impedance which varies with the amplitude up to approximately 100 ohms for driving high impedance circuits. The low level output is used when it is desired to drive low impedance cables terminated in their characteristic impedance. With the use of attenuators in connection with an external mixing network matched to the attenuator impedance, it is possible to obtain a large difference in pulse amplitude. This condition is useful in measuring the dynamic range of wide band amplifiers.

The essential difference between Model 903 and Model 4904 is that the pulse forming circuits in the Model 4904 utilize hard vacuum tubes whereas the Model 903 uses thyratrons. As a result of this, the pulse shapes are superior to those from the Model 4904. A comparison of the rise time, decay time and minimum pulse width specifications will bring out this fact. On the other hand, Model 4904 is superior with respect to pulse width, separation and repetition rate. Furthermore, Model 4904 can be driven externally by standard sine wave generators as well as by pulses. Model 903 can be driven externally only by pulses.





EASE* ANALOG COMPUTERS

EASE* ANALOG COMPUTERS

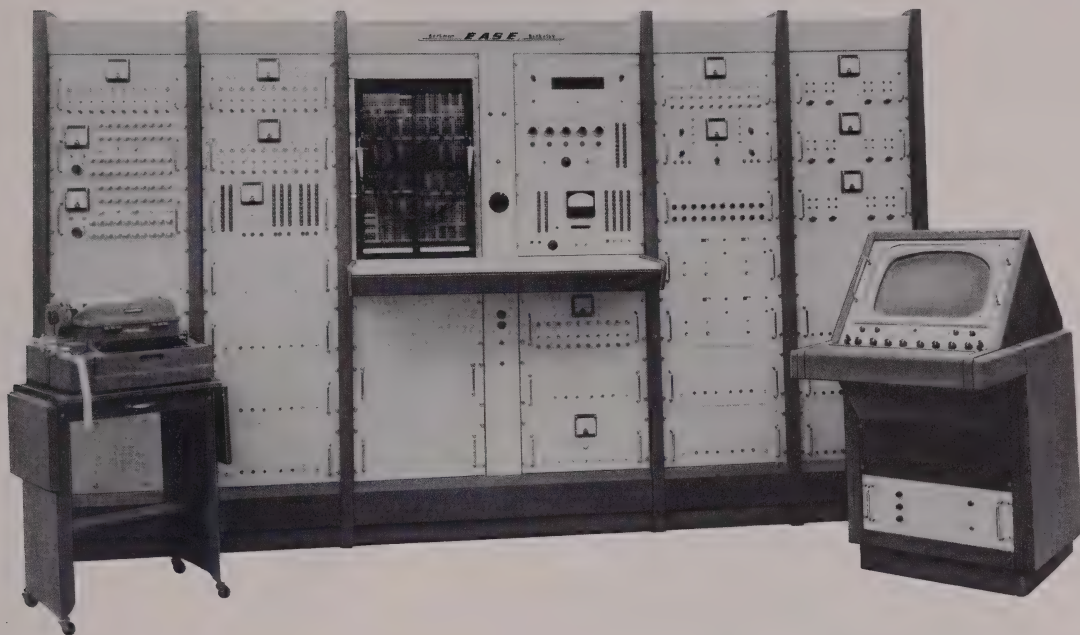
EASE* PRECISION COMPONENTS FOR CONTROL SYSTEMS

MODEL 1191 GENERAL PURPOSE SERVO MULTIPLIER

MODEL 1048B DC AMPLIFIER

MODEL 1157 DUAL ELECTRONIC MULTIPLIER

T.M.



The EASE* 1100 Series with DO/IT

New operating techniques and improved components in EASE* 1100 Series analog computers reduce human error, set-up time, and check-out time. New features include automatic problem checking, complete pushbutton monitoring system, and a fully shielded, color-coded patch board. These features, plus DO/IT (Digital Output/Input Translator) make possible a computer system of any size by eliminating the prohibitive operative cost of large scale installations.

The exclusive DO/IT system, using punched tape to set up and check problems, saves hours of programming time. DO/IT's main functions:

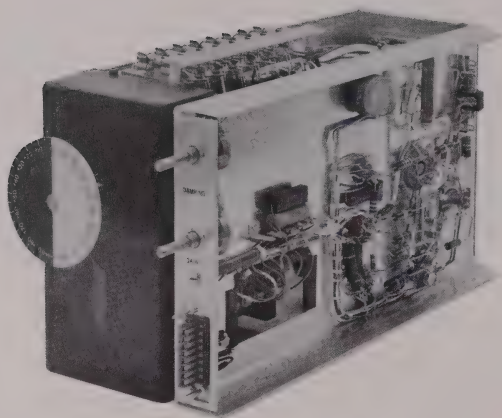
1. Sets and confirms coefficient potentiometers automatically from a previously punched and checked paper tape.
2. Reads and prints settings of each coefficient potentiometer in the computer and simultaneously punches a tape for later re-entry.
3. Scans and prints out all pertinent voltages within the computer, including amplifier outputs, function generator outputs, and multiplier outputs.

Patch bay capacity of the 1100 Series is 2,128 to 3,600 terminals. A typical setup uses 100 DC amplifiers, 16 servos, 200 DO/IT controlled attenuators, 20 electronic multipliers, 20 function generators, and 250 spare terminals.

Computing resistors are maintained at an absolute accuracy of better than .01% in a temperature controlled oven. The oven holds these accuracies despite ambient changes of 70° to 110° F. and line voltage changes from 105 to 130 volts. With this high order of thermal stability, the EASE* computer is independent of temperature change.

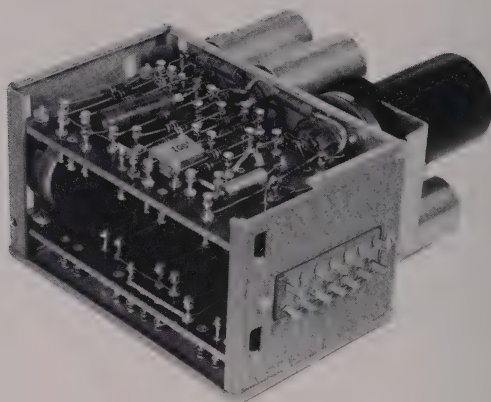
An improved servo-set potentiometer system permits adjustment of potentiometers to an accuracy of 0.01% in less than 3 seconds average time.

Specification and design details on the 1100 Series computer and its components will gladly be supplied on request. Prices on the computer systems may be obtained by writing Sales Manager, Computer, Berkeley Division of Beckman Instruments, Inc., Richmond, California.

**Model 1191****Model 1191 General Purpose Servo Multiplier**

Up to five variables are multiplied by a sixth in the Model 1191 Servo Multiplier. One, two, or three of the five computing potentiometers can be supplied as sine-cosine resolvers. Amplifiers are removeable for ease of maintenance. The front panel contains servo gain and damping controls, as well as servo error light and a shaft position indicator.

No dither is employed, thus minimizing potentiometer wear. Selection of internal or external feedback reference

**Model 1048B**

is made through a relay. Servo Multipliers can also be supplied with such special features as a synchro or one extra potentiometer mounted on the potentiometer shaft, additional taps up to 33 total per potentiometer, and various non-linear resolvers.

Model 1048B DC Amplifier

This new version of the Model 1048 amplifier, which has become a standard component for industry, features higher out-put current (better than 20 ma) and premium tubes with redesigned circuits for increased tube life.



Model 1157 Dual Electronic Multiplier

Beckman/Berkeley's Model 1157 electronic multiplier offers both high accuracy and wide frequency response. It is the most accurate tool available for multiplying two varying voltages in the range of $+100$ to -100 volts. In addition, the carrier frequency of Model 1157 may be increased, providing greater band width for the output variable.

Another important feature of the new EASE* multiplier is its versatility. By energizing a relay within Model 1157, the unit becomes a divider without the use of any external components. Its internal amplifiers may be used as operational amplifiers at the user's discretion, increasing the capacity of existing equipment. These internal amplifiers are chopper stabilized for low drift. Rugged construction, the extensive use of premium components and plug-in modules, including amplifiers and switching circuitry, simplify maintenance and improve reliability.

SPECIFICATIONS

Static Accuracy

NARROW BAND RANGE: Product accurate to better than 0.01 of full scale in any one quadrant (full scale = 200 volts). Product accurate to better than 0.025% of full scale in all four quadrants.

WIDE BAND RANGE: Product accurate to better than 0.05% of full scale in any one quadrant. Product accurate to better than 0.1% of full scale in all four quadrants.

Drift

NARROW BAND RANGE: Less than 20MV (0.01% of full scale) over any 6-8 hour period.

WIDE BAND RANGE: Less than 60MV (0.03% of full scale) over any 6-8 hour period.

Divider Operation

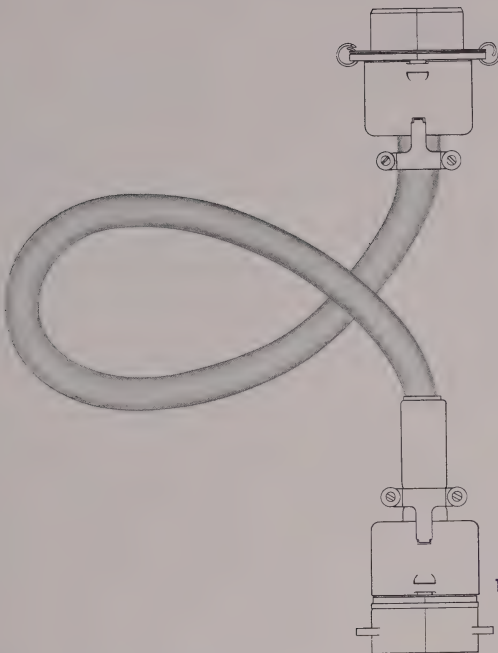
Provides circuitry for converting each multiplier channel to a divider by energizing a relay from patchboard. Output = $100X/Y$; Y negative.

Amplifier Use As Inverters

Patchboard energizing of a relay allows two Models 1048B Amplifiers per channel to be used as inverters when unit is not being used as a multiplier.

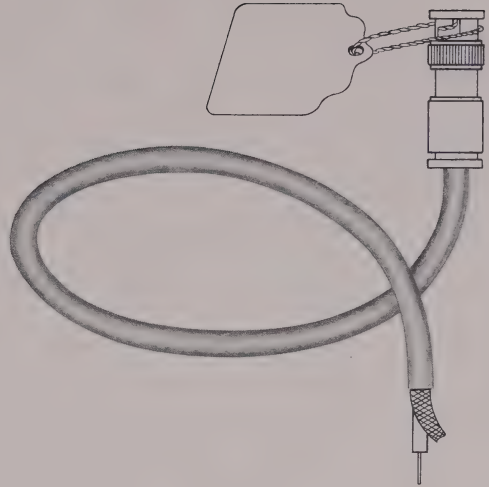


CABLES



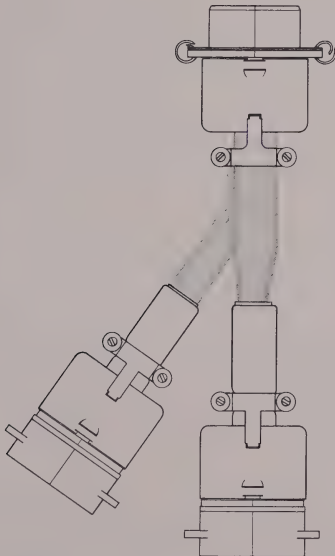
18-9631— Cable, 120 inches, 40 Conductor with Male and Female Connectors for use as extension cable for digital printer, inline indicator, etc.

35.00



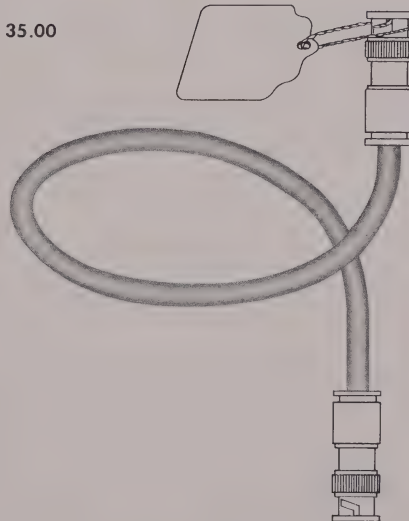
18-0776— Cable, 72 inches, 1 BNC Male Connector

3.00



18-9625— Cable, 6 inches, 2 BNC Male Connectors
 18-9626— Cable, 15 inches, 2 BNC Male Connectors
 18-9627— Cable, 24 inches, 2 BNC Male Connectors
 18-9628— Cable, 48 inches, 2 BNC Male Connectors
 18-9629— Cable, 72 inches, 2 BNC Male Connectors
 18-9630— Cable, 120 inches, 2 BNC Male Connectors

3.00
 3.25
 3.50
 4.00
 4.50
 5.00



18-6739— Cable Junction 8 inches, 40 Conductor with 1 Male and 2 Female Connectors

40.00

(Other cable lengths quoted on request)

MODIFICATIONS

Two groups of modifications are available from Beckman/Berkeley, standard and special.

Standard modifications, offered on a "routine" basis, do not affect delivery. A list of standard modifications appears at the close of this section. Applicable modifications for a given instrument are noted in the pertinent specifications.

Non-routine or special modifications are the product of our Special Products Group, formed to satisfy your

individual instrument requirements. Consisting of experienced technical and administrative personnel, this group is well-qualified to alter standard instruments or design new ones to your unique needs. By and large, our policy is to tailor standard modules in a form that calls for minimum maintenance.

Your inquiries are invited through our nationwide engineering representative network or directly.

STANDARD MODIFICATIONS

Modification B	Incorporates additional circuitry to extend time base by a factor of 10. Price \$70.00
Modification C	Adds 4 digit mechanical register and associated drive circuit. Price \$80.00
Modification D	Adds temperature controlled crystal for greater stability. Price \$30.00
Modification E	Extinguishes DCU's during scaling. Price \$65.00
Modification F	Combined Modifications B, D and R plus panel mounted input sensitivity meter. Price \$140.00
Modification G	Provides automatic time base scanning. Automatic operation obtained by the addition of a preset timer. Permits selection of precise time bases from 3 to 60 seconds. Operation, including recycling, is completely automatic. Price \$130.00
Modification H	Standard transformer replaced by unit having two tapped primary windings allowing operation from 210, 222, or 231 volts $\pm 10\%$ in addition to the 105, 117, or 126 volt $\pm 10\%$ operation normally supplied. Frequency 50-60 cycles. Supplied wired for 222 volt $\pm 10\%$ operation with proper line fuses. NOTE: Crystal oven is rewired to operate only when Power Switch is ON. Price \$25.00
Modification J	Provides 2 mc B channel and higher frequency DCU's (711AH and 713AH instead of 707AH and 705AH) to extend upper range to 2 mc. Price \$80.00
Modification K	Increases input sensitivity from 0.1 volts to 5 millivolts at 5 cps providing operation from flow meter transducers. Price \$50.00
Modification L	Provides for external preset from remote locations. Price \$50.00
Modification P	Provides binary coded readout for driving Digital Recorder or Inline Readout. Price \$30.00
Modification R	Provides for relay rack mounting. No charge on most models when specified on original order.
Modification T	Combined Modification V and modified time base giving 0.5 second instead of 1 second. Price \$85.00
Modification V	Provides drive circuit for driving remote indicator, Model 1941 or 1941X. Price \$50.00

Prices listed are for modifications performed on standard instruments. Not all modifications are available on all instruments and combinations of modifications should be verified before ordering. Prices and specifications subject to change without notice.

WARRANTY

Instruments sold by Berkeley Division, Beckman Instruments, Inc., (hereafter called "the Company") are warranted only as stated below.

Subject to the exceptions and upon the conditions specified below, the Company agrees to correct, either by repair, or, at its election, by replacement, any defect of material or workmanship which develops within one year after delivery of the instrument to the original purchaser by the Company or by an authorized representative, provided that investigation and factory inspection by the Company discloses that such defect developed under normal and proper use.

The exceptions and conditions mentioned above are the following:

- (a) All instruments claimed defective must be returned to the Company, transportation charges prepaid, and will be returned to the customer with the transportation charges collect.
- (b) The Company makes no warranty concerning components or accessories not manufactured by it, such as tubes, fuses, batteries, etc. However, in the event of the failure of any component or accessory not manufactured by the Company, the Company will give reasonable assistance to the purchaser in obtaining from the respective manufacturer whatever adjustment is reasonable in the light of the manufacturer's own warranty.
- (c) The Company shall be released from all obligations under its warranty in the event repairs or modifications are made by persons other than its own service personnel or authorized representatives' personnel unless such repairs by others are made with the written consent of the Company.
- (d) Except as stated above, the Company makes no warranty, express or implied (either in fact or by operation of law), statutory or otherwise; and, except to the extent stated above, the Company shall have no liability under any warranty, express or implied (either in fact or by operation of law), statutory or otherwise.
- (e) The Company expressly disclaims any liability to its customers, dealers, and to users of its products, and to any other person or persons for consequential damages of any kind and from any cause whatsoever arising out of or in any way connected with the manufacture, sale, repair, replacement of, or arising out of or in any way connected with the use of any of its products.
- (f) Representations and warranties made by any person, including representatives of the Company, which are inconsistent or in conflict with the terms of this warranty (including but not limited to the limitation of the liability of the Company as set forth above) shall not be binding upon the Company unless reduced to writing and approved by an officer of the Company.
- (g) This warranty shall be governed by the laws of the State of California.

Claims for damage in shipment should be filed promptly with the transportation company.

All correspondence concerning the instrument should specify the model and serial number. This information appears on the company name plate. Any inquiry concerning details of operation, possible modifications, etc., should be addressed to the Sales Department, Berkeley division of Beckman Instruments, Inc., Richmond 4, California.

REPAIR SERVICE

Experienced service personnel and special test equipment are available at the factory to perform any necessary repairs. Every effort will be made to expedite the repair of instruments returned for servicing. Repair work will be performed only upon receipt of a written purchase order or authorization. Instruments to be repaired should be addressed to SERVICE AND REPAIR DEPARTMENT with transportation charges prepaid. Repaired instruments will be returned to the purchaser with transportation charges collect.

Berkeley reserves the right to make changes in design at any time without incurring any obligation to modify equipment previously purchased to conform to subsequent design changes.

BERKELEY DIVISION
BECKMAN INSTRUMENTS, INC.

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Beckman/Berkeley Engineering Representatives

Berkeley's world-wide staff of factory trained engineering representatives work closely with our sales office and the customer. They help the customer set up newly-purchased equipment, acquaint personnel with its operation and application, and make sure that it stays in operating order.

The representative's job is not completed until he has "followed-up" to insure that the customer receives maximum use from his instruments. These men will be glad to give you personal assistance at any time. A list of Berkeley representatives follows.

ALBUQUERQUE, NEW MEXICO

V. T. Rupp Co.
8009 Bellamah, N.E.
Phone: Albuquerque 3-3585

ATLANTA 9, GEORGIA

Murphy & Cota
2110 Peachtree St., N.W.
Phone: Trinity 6-3020

BINGHAMTON, N. Y.

Edward A. Ossmann & Associates
147 Front St., Vestal, N. Y.
Phone: Endicott 5-0296

BOSTON, MASSACHUSETTS

Broger Instrument Sales Co.
48 Pearl St., Brookline, Mass.
Phone: Beacon 2-4804

CHARLOTTE, NORTH CAROLINA

Murphy & Cota
2036 Norton Rd.
Phone: Edison 2-7356

CHICAGO 39, ILLINOIS

Ridgway Engineering Assoc.
6100 W. North Ave.
Phone: Tuxedo 9-5715

CLEVELAND 28, OHIO

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